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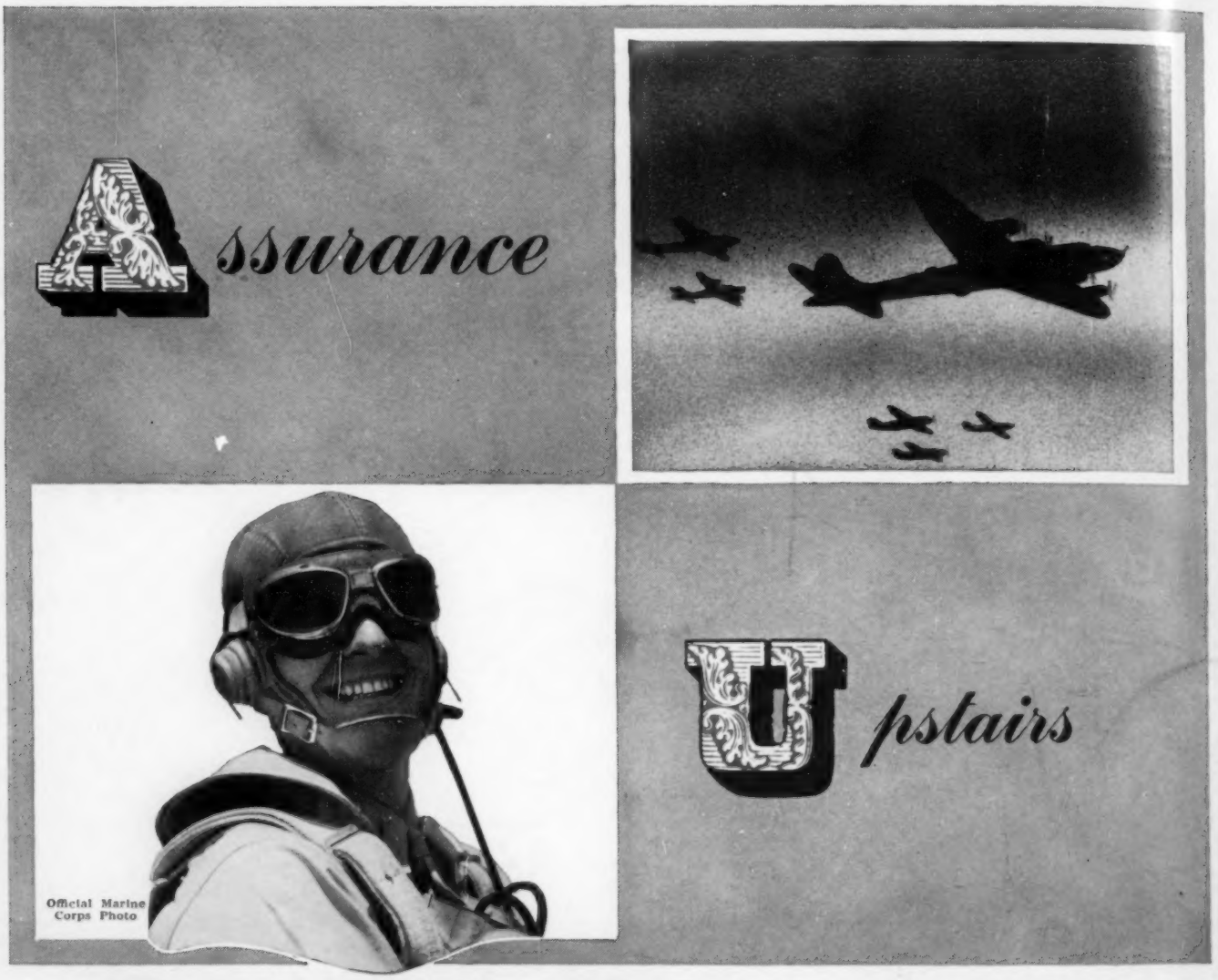
The WELDING Journal

The Journal of the American Welding Society



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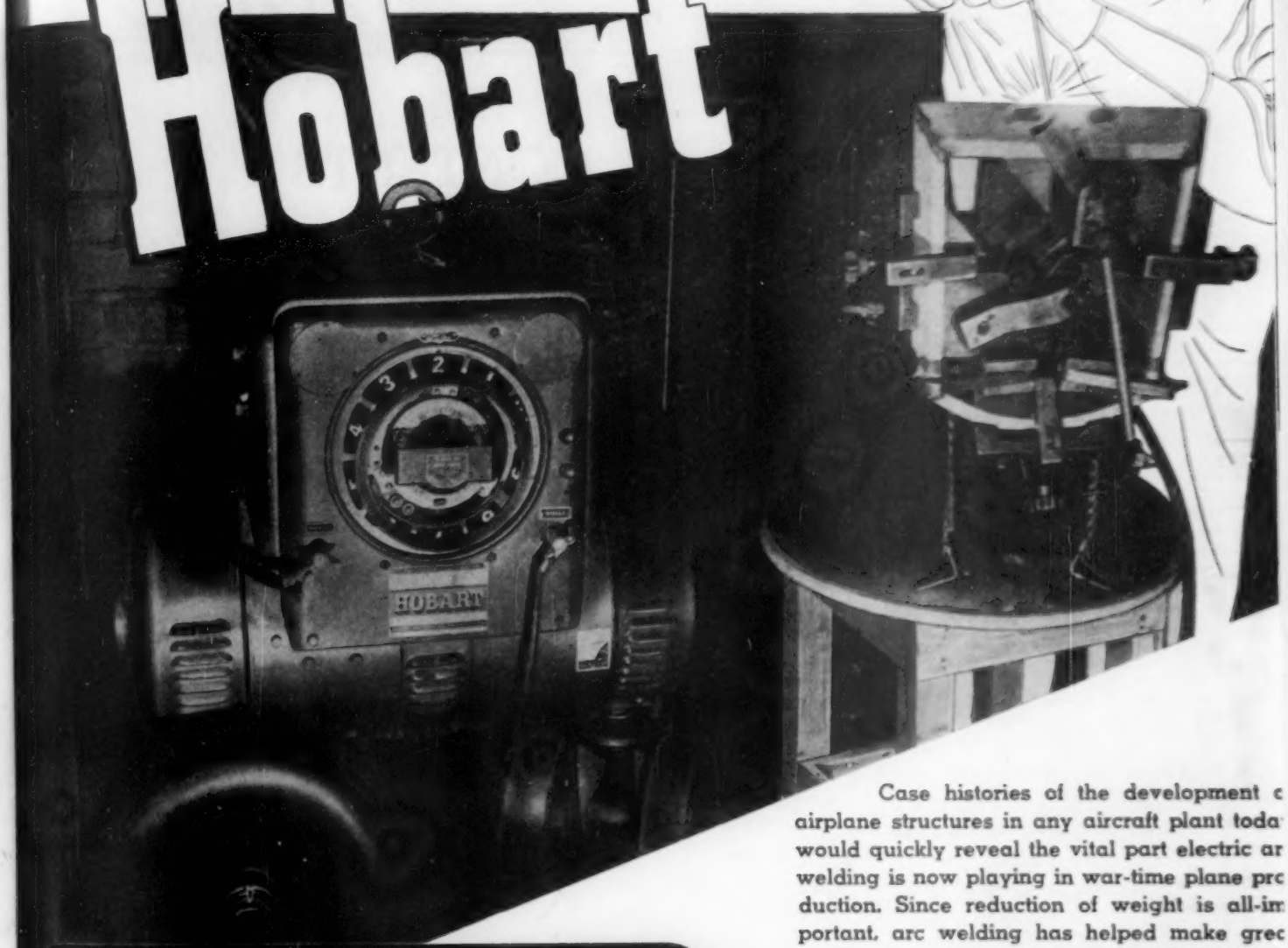

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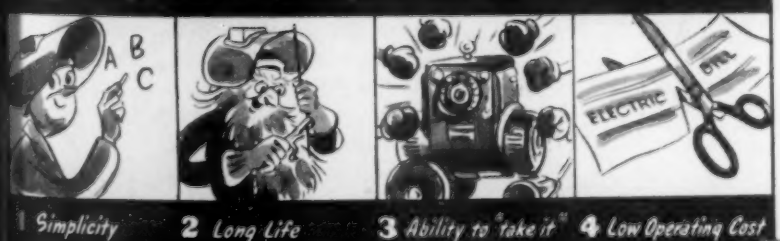

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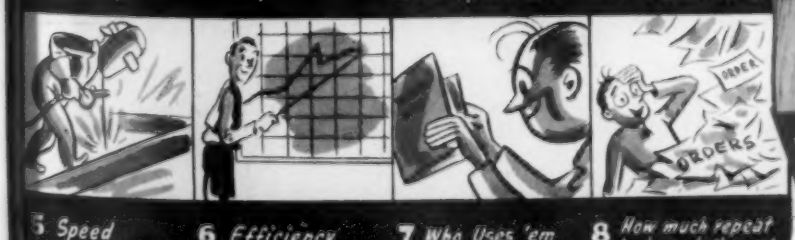

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MARCH 1943

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CONTENTS

TECHNICAL PAPERS, ITEMS AND REPORTS

Welded Caissons for Naval Dry Docks, by Captain C. A. Trexel and A. Amerikian 157

Welding of Aircraft Propeller Blades, by C. A. Liedholm 165

The "Victory" Heating Tip, by A. W. Flint 172

Adapting Automatic Electric Welding to Routine Production, by J. M. Keir 173

Hardness *vs.* Wear Resistance, by J. R. Spence 179

American Standard Code for Pressure Piping 182

Current Welding Literature 187

SOCIETY AND RELATED ACTIVITIES

President Hansen's Son Killed 190

Section Activities Worthy of Special Mention 190

Handy & Harman Gets Production Award Star 190

Communication to the Editor 190

Another Army-Navy "E" Award 190

Office of War Information 190

Electronic Control Specialist Named 190

Index to Advertisers 191

P. D. McElfish 192

Substitutes 192

The Principles of Metallographic Laboratory Practice 192

Obituary 192

Standards Publications 192

Progressive Appointment 194

Arc Welding Capable of Limitless Progress 194

Suggestion Winners Honored by Westinghouse 194

Rebuilding Motor Avoids Using Spare 194

Welding Marine Couplings 196

Data on Corrosion-Resisting and Heat-Resisting Steels 196

How to Figure Arc Welding Speed. 196

Newell Receives Morehead Medal .. 196

Hood Honored 198

Employment Service Bulletin 200

A New, Corrosion Data Work Sheet. 200

New Los Angeles Office for Handy & Harman 200

Brazed Ends Make Wire Rope Safer to Handle, by F. L. Spangler ... 200

American Red Cross 200

Construction of Mast Columns for Heavy Cranes 202

Arc Welding Is Spectacular 202

New Products 204

Section Activities 210

List of New Members 213

Members Reclassified During Month of January 216

WELDING RESEARCH SUPPLEMENT

Our University Research Workers and Their Laboratories 97-s

The Use of Tubular Steel Sections in Structures, by A. Quisling and C. M. Cosman 101-s

Behavior of Spot Welds Under Fatigue Stress, by A. M. Unger, H. A. Matis and E. P. Gruca 135-s

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The American Welding Society
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Welded Caissons for Naval Dry Docks*

By Captain C. A. Trexel (C.E.C.) U.S.N.† and A. Amirikian†

A DRY dock or graving dock is generally described as a water basin with a removable gate, which provides a dry berth for maintaining, repairing or building ships. Since the early days of navigation, dry docks have played a prominent part in the progress of shipbuilding. Because of the nature of the services which they render, the history of their growth and development is closely allied with that of ships. Paralleling the development of the merchant fleet, the crude basin of the wooden-ship era has gradually emerged into the present-day dry dock of immense dimensions and streamlined appearance (see Fig. 1), as a worthy counterpart of the modern ocean liner and a contributor to its successful operation.

Dry docks are likewise of primary importance to the maintenance and operation of the naval fleet. While some service to smaller craft is rendered by marine railways, the repairs to major vessels must necessarily be carried out in floating or graving dry docks. The importance of such shore facilities, particularly in time of war, needs no elaboration. Without them ships would, in time, become immobile and useless because of fouling of bottoms, damaged propellers or rudders, and many a battle-damaged ship would be lost.

* 1st Grand Award ($13,700), paper in the 1940–42 Industrial Progress Award Program sponsored by The James F. Lincoln Arc Welding Foundation, Cleveland, Ohio. The award papers showed a possible saving of $1,825,000,000, including 7,000,000 tons of steel and 153,000,000 man-hours of labor available by application of arc welding.

† Director of Planning and Design and Designing Engineer, respectively, Bureau of Yards and Docks, Navy Department, Washington, D. C.

Dry Dock Closures

The entrance closure is an integral part of a basin dry dock. The two factors governing its selection and design are mobility and strength. The former is required for clearing the entrance and thus enabling the ships to float in and out of the dock. The latter is an obvious requirement for withstanding the external water pressure when the dock is pumped out. Mobility may be provided by any of three types of closures: hinged miter gates, similar to canal lock gates; sliding or rolling caissons; and removable floating caissons. Gates are installed in many European dry docks. The sliding type of caisson, which is drawn into a recess at the dock entrance to permit the entrance or removal of a ship, is a favorite at English and British colonial dockyards. In American practice, the floating caisson is the most commonly used form of dry dock closure.

Floating Caissons

As the derivation of the word would indicate, a caisson is essentially a box. This box is composed of a system of interior framing and an enveloping skin plating. The interior framing, in turn, consists mainly of a series of trusses or girders, spanning longitudinally and transversely. The skin plating, which is of watertight con-

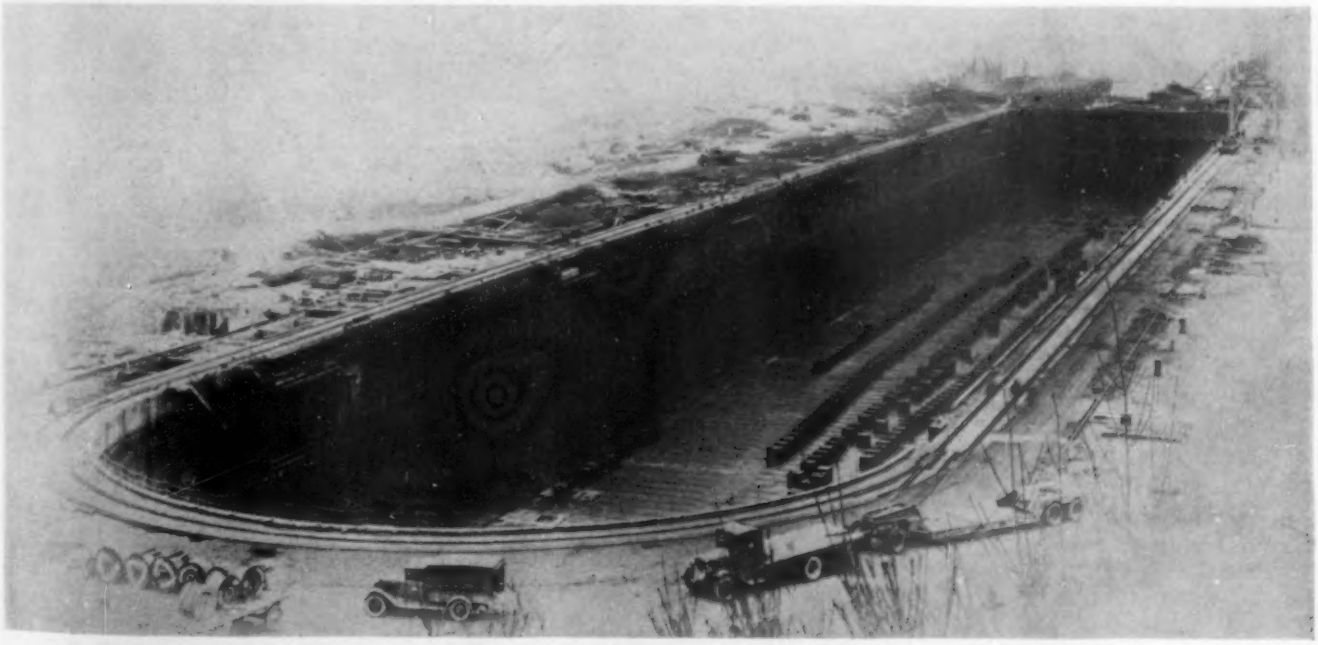


Fig. 1—View of a Modern Dry Dock, with Caisson in the Background

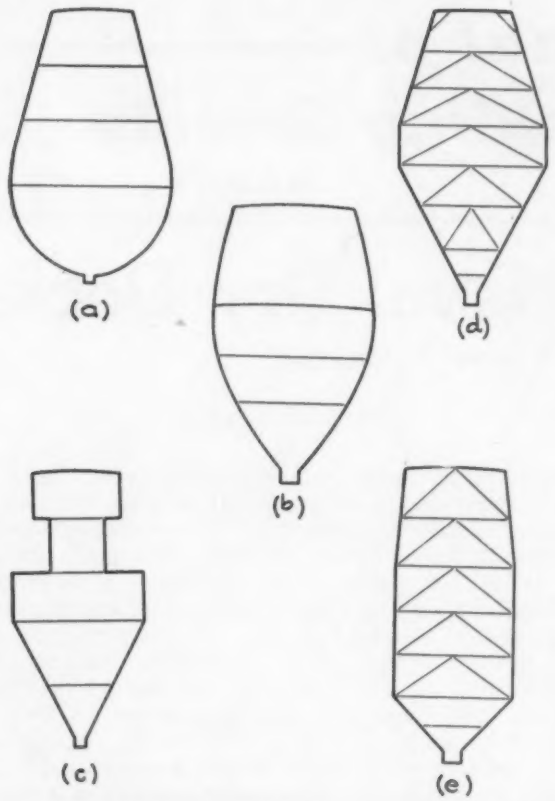


Fig. 2—Typical Cross-Sectional Outlines of Dry Dock Caissons, Shaped as: (*a*) Bulb; (*b*) Ship; (*c*) Hydrometer; (*d*) Barrel; and (*e*) Box

struction, is supported by a set of girts or stringers forming the secondary framing.

The cross-sectional outline of a caisson is determined from the conditions of stability and minimum draft in flotation, and the necessary strength when in the seat and subjected to the unbalanced water pressures. As in the case of ships, the cross-sectional outline has undergone considerable change. In the early days of naval construction, when labor was inexpensive, and the time element not so pressing, the general tendency was to choose curved outlines of what would now be considered doubtful efficiency. Some of these outlines are shown in (*a*), (*b*), (*c*) and (*d*) of Fig. 2, representing, in that order, the bulb, ship, hydrometer and barrel-shape types of caissons formerly used. In (*e*) we have the modern, simple, yet efficient, box-type framing outline, used by the Bureau of Yards and Docks, Navy Department, since 1940. The latter follows structural framing practice rather than the more costly orthodox ship construction used in former caissons.

In the earlier days of shipbuilding, when the dock closures were of rather small dimensions, caissons or gates were built exclusively of timber. Later, with the advent of the iron ship, iron was utilized to a great extent. In the present era of naval construction, caisson material consists mainly of steel.

Analysis of Caissons

In the earlier forms of framing arrangement, the design of the caisson involved no complex problems. The panels of timber were analyzed as simple beams spanning the two walls of the dry dock, and each carrying the hydrostatic load within its boundary. According to this arrangement, the entire load was transmitted to the side walls of the dry dock, and the pressure distribution was assumed to vary from zero at the top of the side wall seats to a maximum at the bottom.

With the introduction of the so-called grid-system of framing, in which the horizontal girders were supplemented by a similar series of vertical frames, the analysis became statically indeterminate. The function of the vertical framing was twofold: (*a*) to transfer a part of the water pressure from the heavily loaded lower girders to the more lightly loaded upper girders and (*b*), to assist the horizontal girders by transmitting a part of the hydrostatic load to the bottom seat.

A simplified concept of the main framing is shown in Figs. 3 to 5. The outline of the main framing or grid is indicated in Fig. 3; Fig. 4 is an exaggerated view of the deflections of the grid under concentrated panel loads;

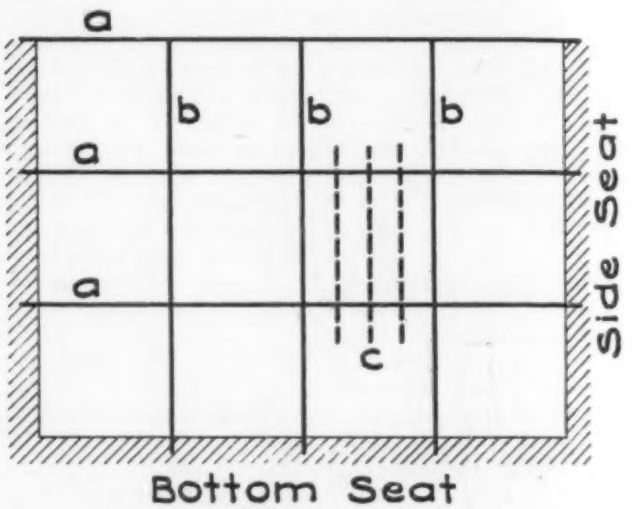


Fig. 3—Plan of Caisson Framing: (*a*) Horizontal Girder; (*b*) Vertical Frame; and (*c*) Secondary Framing

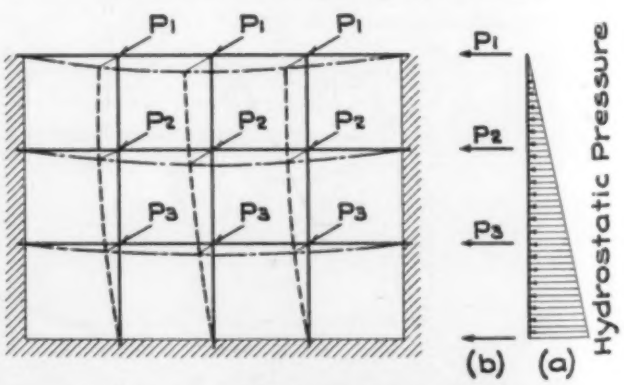


Fig. 4—Deformation of Grid Under Concentrated Panel Loads. (*a*) Distributed Water Pressures; (*b*) Resultant Panel Loads

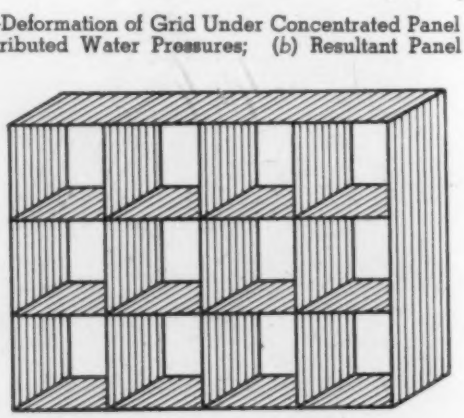


Fig. 5—Main Framing Arrangement of Caisson, with Shell Plating Removed

and Fig. 5 is an isometric presentation of the grid or cellular box, consisting of the interior framing with the shell plating removed.

The hydrostatic load acting on the box is transmitted to the three supports first by local bending of the various members of the secondary framing and then by bending of the main framing as a whole. For the first part, the problem is rather simple. The shell plating, spanning over the secondary supporting frame, acts as a continuous member to transmit the distributed loading to the supporting stringers. The latter, in turn, also bending as continuous beams, transfer the water pressure to chords of the main framing in the form of a series of concentrated loads. The chords, likewise bending locally, carry the intermediate concentrated loads to the main panel points located at the intersections of the vertical and horizontal frames, thus finally resulting in a loading system as shown in Fig. 4. The problem of the bending of the box as a unit under this loading, however, is quite involved, since the equations of static equilibrium alone are not sufficient for determining the two components of each panel load which must be transmitted to the side and bottom seats through the respective framing.

Former Methods of Analysis

Since early days of design, many attempts have been made to simplify the analysis. Some of these efforts consisted of rendering the system statically determinate by various arbitrary assumptions. Others were predicated on dividing the loading between the two directions of bending through supplementary consideration of probable or assumed deflections, and still others were based on the principle of "least work." A brief description of the several methods follows.

Illustrative of the first group, and perhaps the earliest method of analysis, is the so-called method of one-way bending, in which it is assumed that the loading is carried entirely by the horizontal girders and that the vertical frames act merely as bracing members. Obviously, the unsatisfactory basis of analysis and the waste of material resulting from such a design need no elaboration.

The method of assumed deflections had been used for caissons designed up to 1919, which were the last ones built for twenty years, thereafter. While some consideration is given in this method to the role of the vertical frames, at best, it is a crude approximation of the grid theory. To determine the share of loading for each girder, first the form of the probable deflection curve is assumed at the vertical center line of the framing. Then, by trial and error, the loading is adjusted and the flange material for each girder is proportioned to conform to the respective maximum deflection on the assumed curve. While the equilibrium conditions are satisfied in the solution, the method is defective in that the same panel loads are used for all vertical frames, regardless of their location with respect to the supports. As a result, the distribution of loading between the two directions of framing does not represent the true conditions nor the one requiring the least sections in bending.

In the method of "least work," the framing system is assumed as a grid, and the panel loads carried in one of the two directions are considered redundant forces and their intensities determined from the equations of "least work."

Concept of Former Method

In the older methods of design the strength of the shell or skin plating was only partially utilized in the bending of the caisson as a whole, the assumed contribution being limited to furnishing a certain amount of flange material for the main frames. In effect, such a concept is analogous to considering the caisson as a box having its top and bottom perforated with rectangular openings. Figure 6, showing the plan view of the plate panel, illustrates this concept. Here, the unshaded area of the diagram indicates the effective part of the plating, consisting of a series of vertical and horizontal strips. Each strip represents the effective flange plating acting in conjunction with the girder or frame at the respective location, the width being governed by the plate thickness.

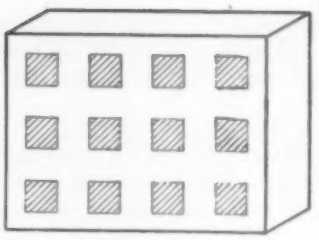


Fig. 6—Concept of Grid Framing as Applied to a Box

Concept of New Method

The imaginary holes in the plating had been introduced with a view to divorcing the direct interdependency of bending in the two directions, and thus simplifying the analysis. Obviously, because of the solid skin plating, no bending of the nature of an open-grid framing can take place. If it be assumed that the plating is adequately anchored or connected to the interior framing, when the box is bent, the original plane flanges are forced into dished-in or spherical contours, conforming to the bending curvatures in the two directions. As a result, the flange plating is not only subjected to bending fiber stresses but to twisting strains as well, the latter attaining their maximum intensities at the four corners where the bending curves in the two directions merge into a single common curvature. Compared to the two-way bending of a grid, the twisting resistance of the plating has the effect of equalizing and relieving the bending stress of the framing, thereby resulting in a more satisfactory and economical design.

Analysis of Caisson as a Cellular Elastic Slab

The bending phenomenon just explained is that of an elastic slab. As stated above, if the skin plating and the various members of the framing are securely connected together to form a rigid unit, then the caisson may be considered as an elastic slab in which, in lieu of a solid cross section, the material is concentrated in the flanges and in a series of web frames to form a cellular box.

Design of Caissons

In the fall of 1939, construction was nearing completion of a caisson for dry dock A at Navy Yard X. The caisson, the largest closure in span and depth to that date, had, for lack of time to prepare a radically new design, been designed in accordance with the Bureau's former conventional method of analysis discussed above, and had riveted connections. It was of the barrel-shape type, with a maximum beam of 27 ft., a depth of 54 ft. and a maximum length at the top of 150 ft. The details followed the general pattern of accepted standards

of riveted construction. The total weight of the caisson, exclusive of the concrete ballast, was 2,256,700 lb.; the cost, $389,650, and it was completed in 18 months.

New Caisson Design

At the time of construction of caisson A, a very large expansion program of docking facilities was just getting underway. First on the list were two new dry docks having entrance sections identical with that of dry dock A, one of them located at Navy Yard X and the other at a distant Yard Y. Under normal conditions, the logical procedure would have been to duplicate the former design for which plans were available. However, having conducted considerable research and investigation in the field of elastic slab analysis with a view to possible application to the design of caissons, and having developed a simplified computation routine from the obviously involved theory, the Bureau decided to prepare a new design based on the elastic slab concept.

Riveted Framing

The new analysis being a radical departure from conventional methods formerly used, it was deemed prudent in the first design to confine pioneering to the analysis only, and to design the new caisson for riveted construction.

In preparing the new design, the available data of the caisson for dry dock A (last conventional design) were utilized both as a guide as well as a basis of comparison. Figure 7 shows the main features of the new framing. The new cross-sectional outline, in the form of a slenderized box, presented a striking contrast to the bulky, barrel-shaped outline of the former design. Other changes consisted of revised girder and frame spacings, elimination of double plates from girder flanges and redistribution of material throughout the framing.

The estimated weight of the caisson, exclusive of concrete ballast, was 1,950,000 lb., representing a reduction of 306,700 lb. from the weight of the former design.

Welded Framing

While the design drawings for the new riveted caisson framing were in course of preparation, the question was raised whether the original decision to use riveted construction ought not to be reconsidered in view of the number of new caissons involved and the possible large economies which might be achieved by the use of welding. Up to that time the Bureau had not used welding in the fabrication of its floating caissons. As support for the adoption of welding, it was argued that, since the elastic cellular slab concept was predicated on rigidity of connections, there was more justification for using the new analysis in welded construction of proved rigidity than in riveted construction of somewhat dubious rigidity. As a compromise, and to obtain a direct comparison, it was agreed to prepare an alternate design of welded framing, and to submit both schemes of construction for bids.

Details of Welded Design

The success of any welded design depends greatly on its planning and development as a new and entirely distinct structure, free from the influence of the details of the riveted design which it replaces. With this in mind, in preparing the details of the alternate welded design, the parts for each member of girder and frame were carefully selected to provide not only the lightest weight and maximum strength but also the most advantageous section for welding. To this end, generous use was made of serrated channel sections, cold-formed angle sections and wide-flange tee sections. Figure 8 illustrates the basic details of construction. It is to be noted that all horizontal girders have a combination tee-angle flange section. The small tees, while not needed for strength, were added to provide a landing and backing strip for welding of the horizontal seams of the shell plating. The connections were further improved

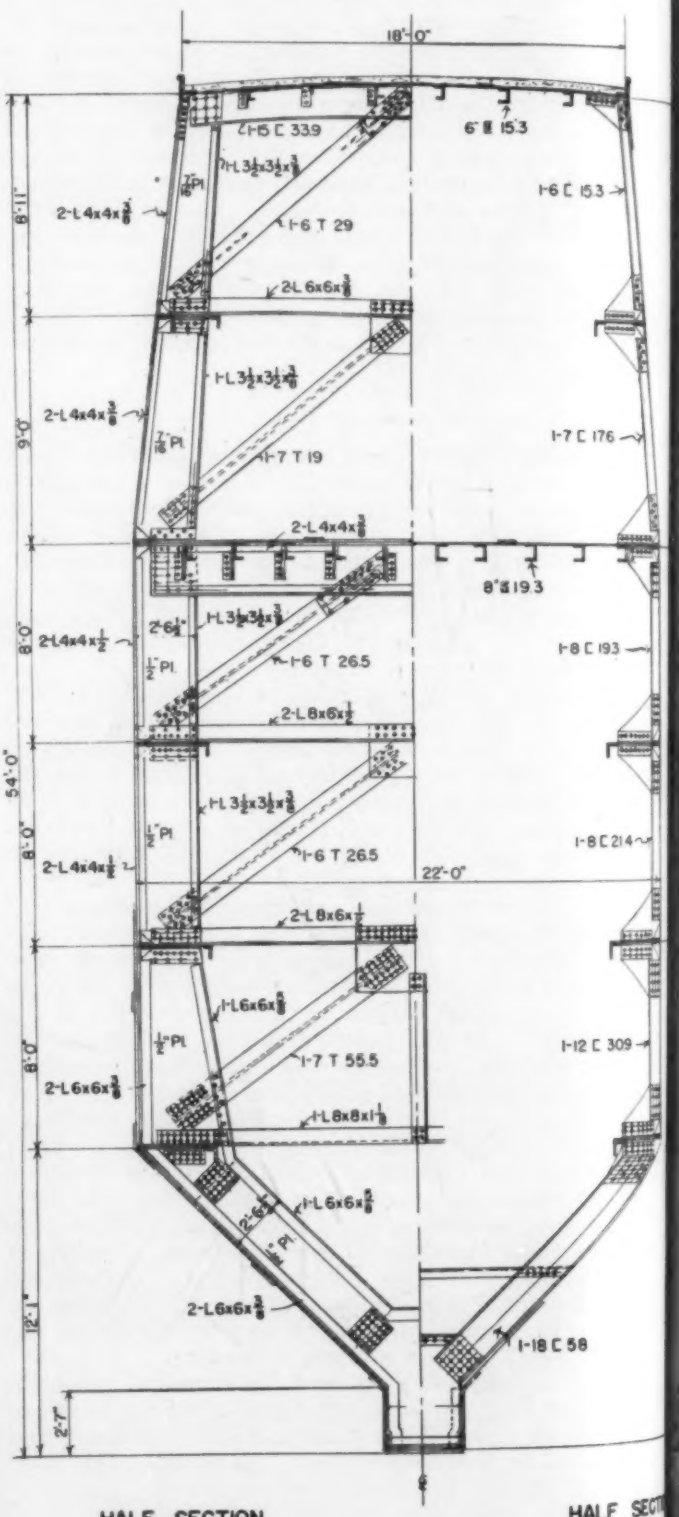


Fig. 7—Cross Section and Typical Framing Arrangement of Riveted Caisson, Designed by the Elastic Slab Theory

by substituting two separate fillet welds in lieu of the customary butt weld, thus allowing a tolerance gap between the edges of two adjoining shell strakes, at the same time reducing the possibility of locked-up stresses which might result from long butt seams. The employment of serrated sections, results in a saving in channel material and the use of a minimum amount of welding with sealed connections at the lines of contact with the plating. The flanged sections of the girder and

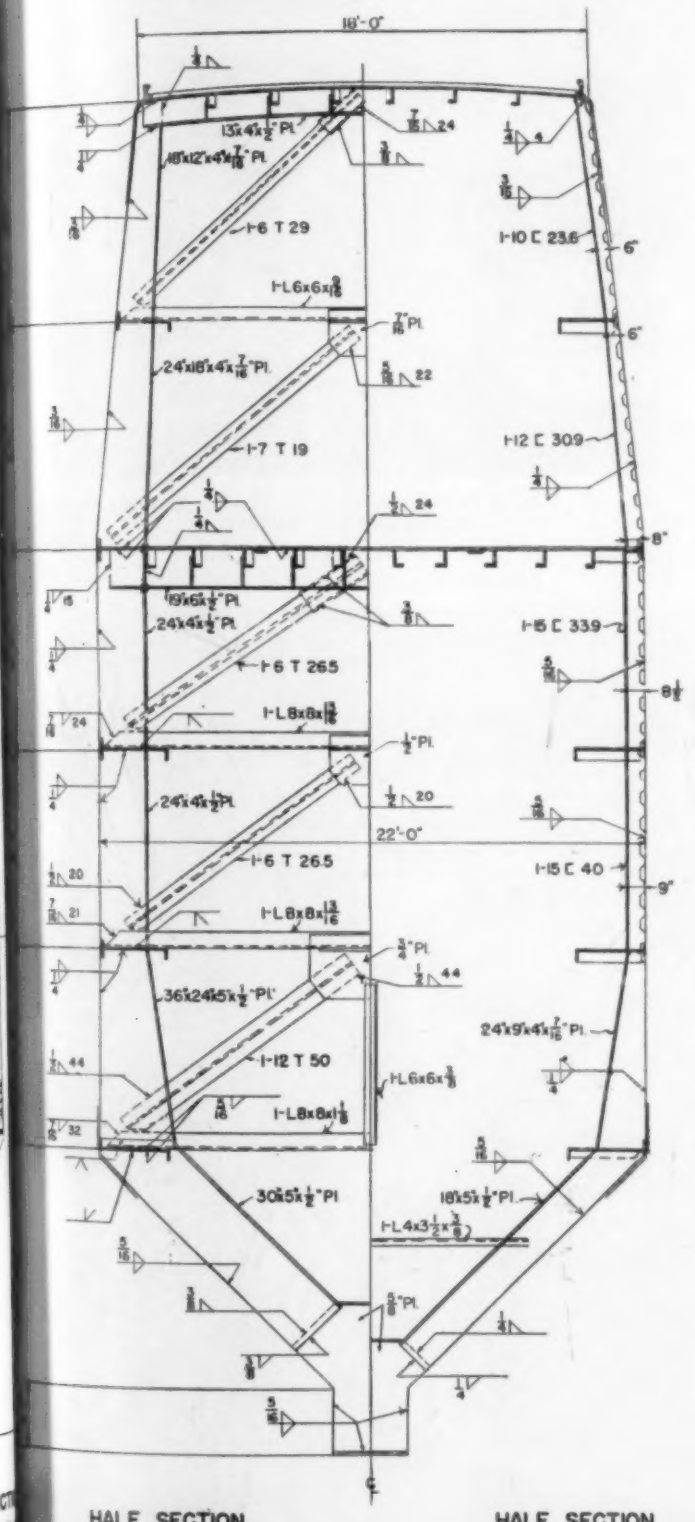


Fig. 8—Cross Section and Typical Framing Arrangement of a Welded Caisson, Designed by the Elastic Slab Theory

frame chords furnish the required stiffness and stability in flexure, obviating the need of welded legs.

Working Stresses

In determining the amount of welding at the various points, the following unit stresses were used:

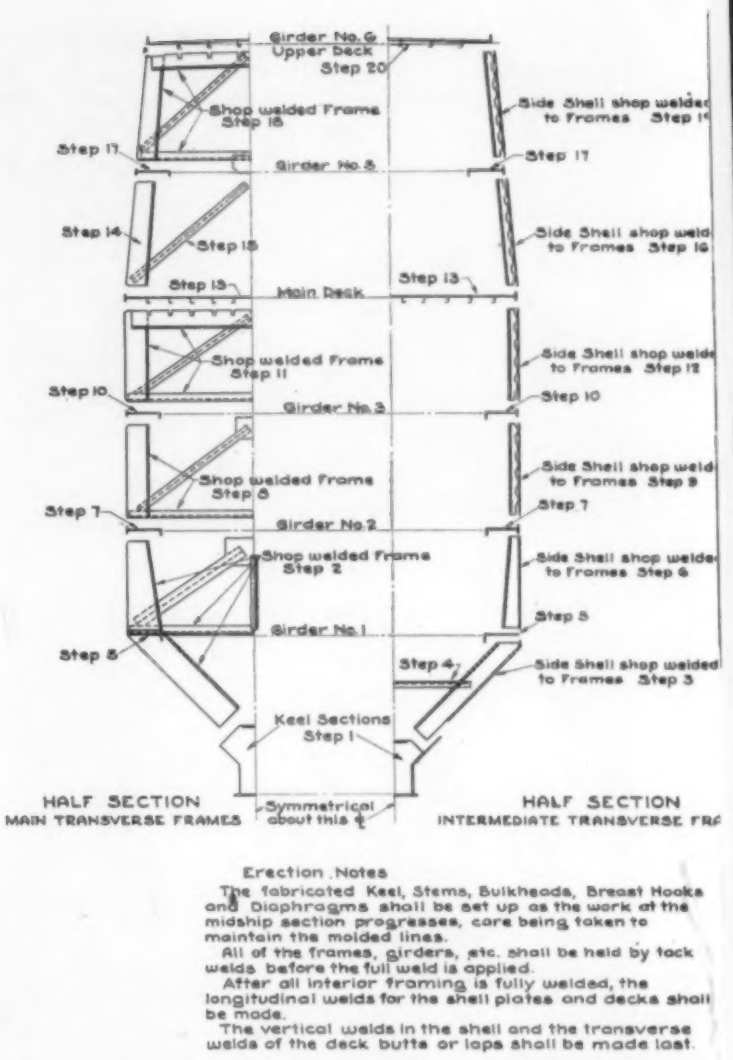
Fillet welds	13,560 psi.
Butt welds:	
Tension	15,600 psi.
Compression	18,000 psi.
Shear	12,000 psi.

Other details and welding requirements were in accordance with Bureau of Yards and Docks Welding Specs. No. 12yb—Supplement No. 1a and No. 22yb.

The estimated weight of the steel and fittings of the caisson was 1,505,000 lb., or 445,000 lb. less than the weight of the new riveted design, and, 751,700 lb. less than that of the old riveted design.

Comparative Caisson Costs

Drawings for the two designs were completed early in 1940, and submitted for bids. The bids were asked for each caisson separately as well as for the two units together. Eight contractors participated in the bidding, the list including the builder of the Bureau's last riveted design. Of the eight bidders, four quoted prices for the welded design only, three gave incomplete bids for the



Erection Notes

The fabricated Keel, Stems, Bulkheads, Breast Hooks and Diaphragms shall be set up as the work at the midship section progresses, care being taken to maintain the molded lines.

All of the frames, girders, etc. shall be held by tack welds before the full weld is applied.

After all interior framing is fully welded, the longitudinal welds for the shell plates and decks shall be made.

The vertical welds in the shell and the transverse welds of the deck butts or laps shall be made last.

Fig. 9—Erection Procedure of Shop Subassemblies of Welded Caisson

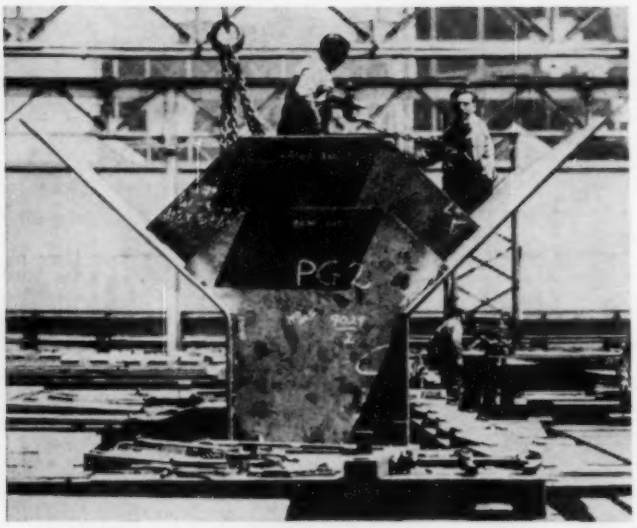


Fig. 10—Shop-Welded Keel Section of Caisson

riveted design and one submitted bids for both designs. The lowest figures were as follows:

(*a*) Welded Design:	
One caisson for Navy Yard X	$266,703
One caisson for Navy Yard Y	276,203
Both caissons	522,570
(*b*) Riveted Design:	
One caisson for Navy Yard X	$355,540
One caisson for Navy Yard Y	366,740
Both caissons	630,600

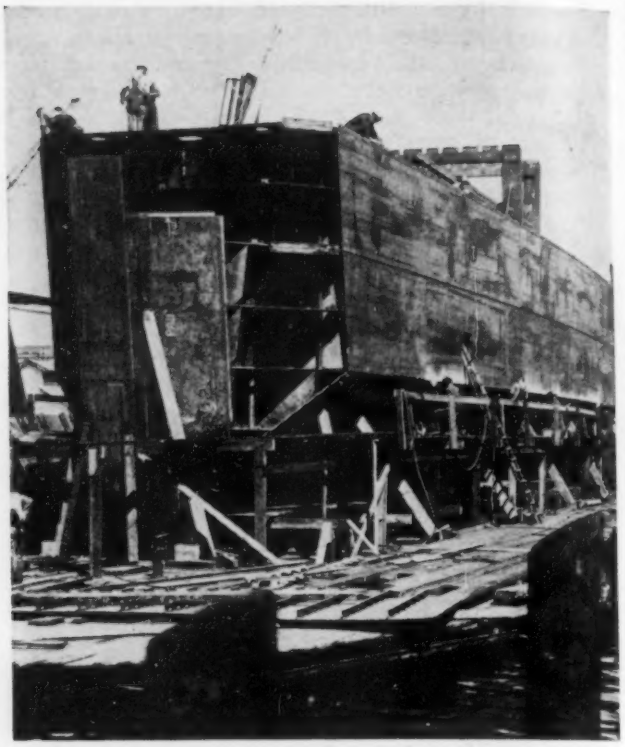


Fig. 12—View of Partially Assembled Caisson, Showing Parts of Stem and End Framing

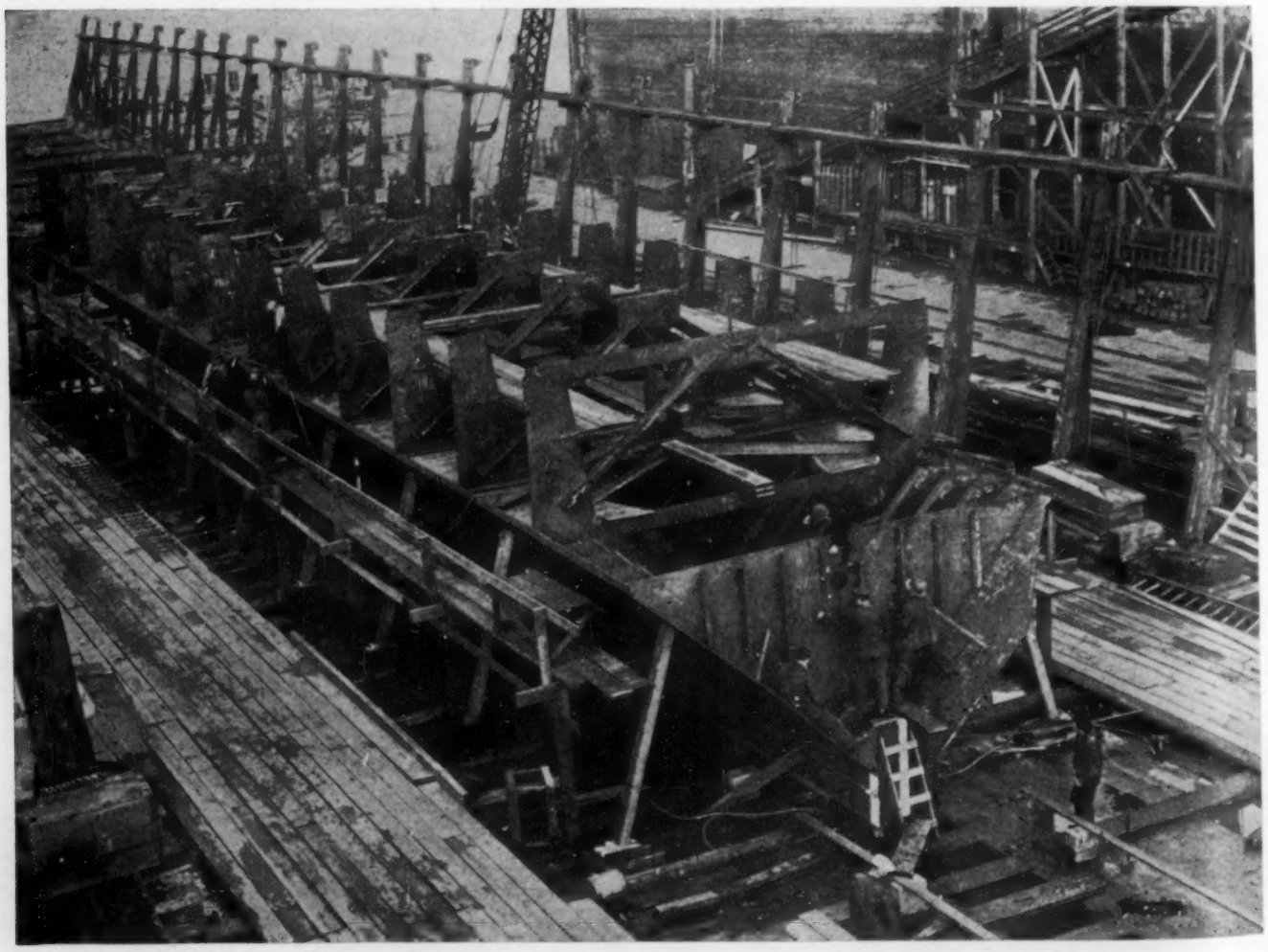


Fig. 11—View of Partially Assembled Caisson Showing Parts of Main Transverse Framing

Fig. 13—Top View of Partially Assembled Caisson, Showing Some Details of the Interior Framing

It is particularly interesting to note that the low figures of the welded group were those of a builder who had actually fabricated the Bureau's last riveted caisson mentioned above, the work being sublet to him by the successful bidder of that project; and, significantly, he had submitted no bids for the riveted group at this time.

Fabrication and Construction

The contracts for the two caissons were awarded to the low bidder of the welded design, and thus the work was being started on the first all-welded caisson construction. The caisson being a floating structure, the event marked also the beginning of a large-scale utilization of welding in such structures under the cognizance of the Bureau.

By the terms of the specification, the contractor was required to submit the proposed method and order of assembly and sequence of welding for approval before proceeding with the actual fabrication. The submitted procedure in outline form is shown in Fig. 9. The erection being confined to the vertical position of the caisson, the proposed method differed but little from the one envisaged in the design. Another clause in the specification gave the contractor the option to use, upon approval by the Bureau, welding details other than those shown on the design drawings. No important changes were, however, proposed to alter the original details.

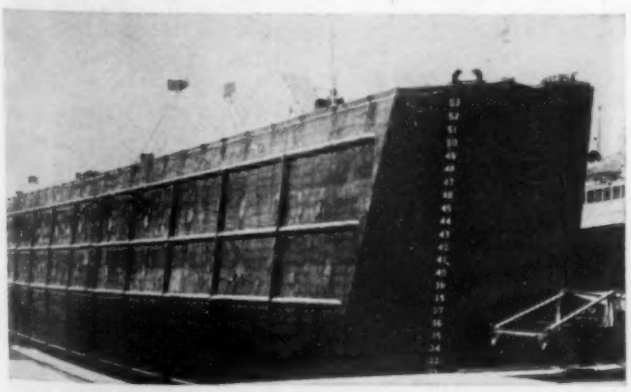


Fig. 14—First All-Welded Caisson Complete and Afloat. Beam 22 Ft., Depth 54 Ft., Length 150 Ft.

Figure 10 shows the placing of the first keel section of the first caisson at the assembly site. Figure 11 shows the assembled keel section and the lower parts of the main transverse framing. Figure 12 is a view of the partially assembled end framing, consisting of a part of the stem section, the breast hooks, the watertight bulkhead and the shell plating up to the elevation of Girder No. 3. In the foreground a subassembled plate panel with serrated-channel stiffeners can be seen. Figure 13 is a top view of the partially assembled caisson, showing some details of the interior framing. Figure 14 shows the completed caisson afloat.

Additional Welded Caissons

As a result of the favorable bids received for welded caissons, a policy was adopted by the Bureau to exclude riveted designs from further consideration and to use welded construction in all subsequent work. Accordingly, on June 1, 1940, contracts were let for the construction of two additional caissons of smaller dimensions, involving 430 tons of steel by welded design.

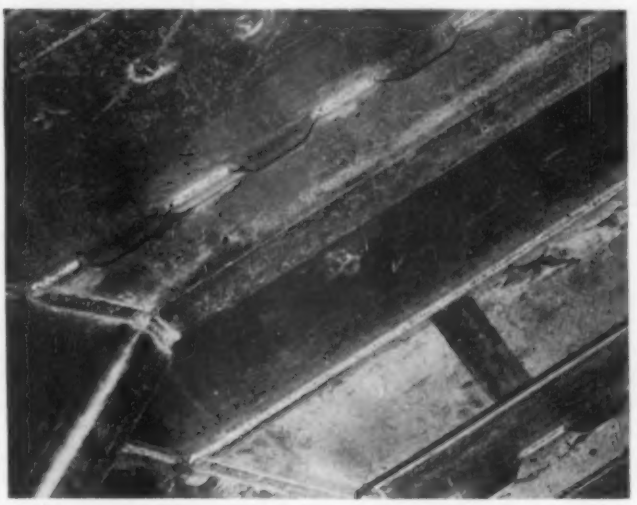


Fig. 15—Close-Up Interior View of Caisson, Showing Joint Details of Main and Intermediate Frames at the Knuckle

Figure 15 shows the joint details of main and intermediate frames at the knuckle. Figure 16 is a view of the caisson at an advanced stage of erection, illustrating the adaptability of welding to high-speed production at the assembly site, in this case showing simultaneous welding by 16 welders (4 inside and 12 outside).

In addition to these four caissons, during the period of July 1940 to January 1942, designs were prepared and contracts were awarded for a number of additional caissons of varying sizes. The total amount of steel required for these new projects is in the neighborhood of 12,000 tons. Some of these caissons have already been completed and are now in successful operation; others are at various stages of completion at fabricating shops or at the assembly sites.

Advantages of Welding

Savings in Cost

One of the first considerations in any project is obviously the cost. The contract prices of the last conventionally designed riveted caisson and the new welded design for the dry docks at Navy Yard X described above, indicate a maximum cost differential of $122,947

for one caisson. Deducting from this sum $34,110 as a saving due to the improved method of analysis, the balance of $88,837 represents the minimum or net saving resulting from use of welding, which is a 25% saving, and is equivalent to approximately $118 per ton of steel used in the welded design. On the basis of the latter figure, the net savings realized from caissons built or presently under contract, involving a total of 14,000 tons of steel, is $1,652,000; and the anticipated savings from projected construction in the immediate future, involving some 30,000 tons of steel, is $3,540,000.

Savings in Weight

As stated in a preceding paragraph, the weight of steel in the first welded caisson was 751,700 lb. less than the former riveted design. Of this total reduction, 306,700 lb. was due to the application of the elastic slab theory to the design and the balance of 445,000 lb. represented the net minimum saving as a result of welding. Expressed in percentages, the reductions from the old and new riveted designs are, respectively, 33.3% and 22.8%, or approximately 0.5 and 0.3 lb. per one pound of metal used in the welded caisson. On the basis of the latter figure, the total savings in weight for the caissons under the present construction program is about 4200 tons, and that for the projected construction will approximate 9000 tons.

Saving in Time of Construction

The time of completion and delivery of the last riveted caisson was approximately 18 months, whereas of the first group of the two welded caissons the first was contracted for and delivered at Navy Yard Y in about 12 months and the second one at Navy Yard X three months later. With the ever-improving technique of welding, shop fabrication is steadily approaching the pace of high production, thus resulting in further shortening of the completion periods. This important time saving element is clearly reflected in recent contracts for welded caissons.

Savings in Maintenance Cost

In floating structures, welded construction possesses a distinct advantage over that of riveted construction. Caulking is used extensively in the latter to provide the required watertightness. Caulking is not only costly but often ineffective, resulting in leakage and corrosion and consequent overhaul and repairs. Welded construction, if properly done, automatically provides watertight seams, and thus assures appreciable savings in the cost of maintenance of the caisson.

Added Strength and Stability

Paradoxical as it may seem, the welded caisson of reduced weight is stronger than the heavier riveted design which it replaces. This is due to the fact that rigidity of connections in the former helps to develop fully the various sections of the framing, at the same time utilizing, in the form of added strength, a part of the savings from the eliminated deadweight connectors as well as from substituted sections of high stress efficiency. In addition, the lighter welded caisson requires relatively shallower draft in flotation and has greater stability.

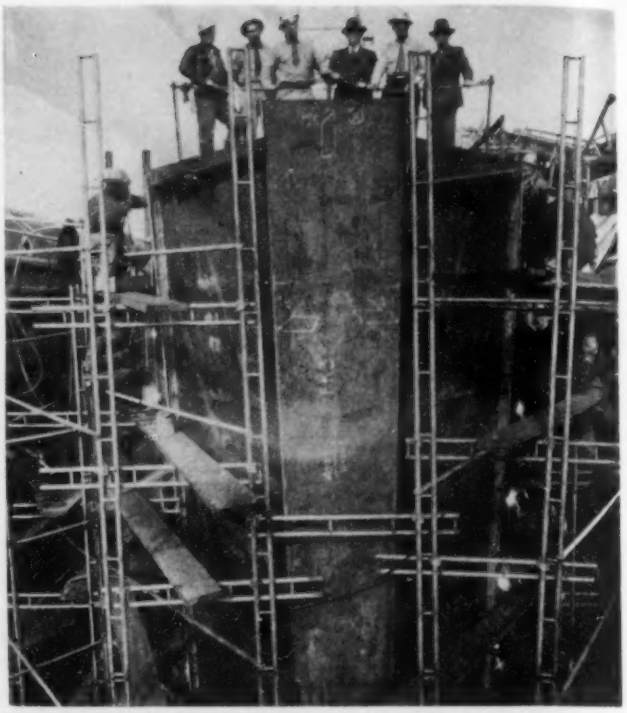


Fig. 16—End View of the Partially Completed Caisson, Showing a Group of 12 Operators Welding Three Strakes of Shell Plating, While 4 Others Are at Work Inside Welding Butts at Two Decks

Incidental Benefit

The advantages enumerated above do not include a still greater benefit which cannot be measured by the standards of a world at peace. A part of the savings in steel tonnage was reused in a different form in some of the caissons, as armor plating, to provide protection against bombing. Another part made it possible to construct some of the spare caissons now in the process of fabrication, and still another part went into the construction of ships and other combat weapons. These transformed savings constitute the real contribution which welding, as applied to Naval dry dock caissons, has made to the violent effort which mankind is now making to insure a more secure and free way of living.

Welding of Aircraft Propeller Blades*

By C. A. Liedholm†

Introduction

AIRPLANE engine power can be utilized only as far as it can be matched by propeller performance. Without exaggeration, the development of larger and faster planes, therefore, may be said to hinge largely on corresponding propeller developments.

Propeller blades nowadays are built from wood, aluminum or steel; the two former types are solid, whereas steel blades are partly or entirely hollow. Figure 1 shows a Curtiss Electric Propeller Blade of the type mentioned last, longitudinally sectioned.

Hollow steel blades permit savings in weight that increase with the propeller diameter: first, because their own weight increases approximately as the square of the propeller diameter, whereas that of solid blades increases more nearly as the cube; and second, because they can be designed with smaller shank diameters than required for blades of lighter materials of corresponding size and, hence, permit a reduction in the size and weight of the hub. Other advantages of hollow steel blades are their greater erosion resistance because of the greater hardness of steel as compared to aluminum alloy or wood and their greater rigidity due to the hollow construction.

Hollow steel blades now are manufactured in sizes up to 18 ft. 0 in. basic diameter for use in three and four-blade propellers for engines of over 2000 H.P. Figure 2 shows a complete three-blade propeller of 16 ft. 6 in. diameter.

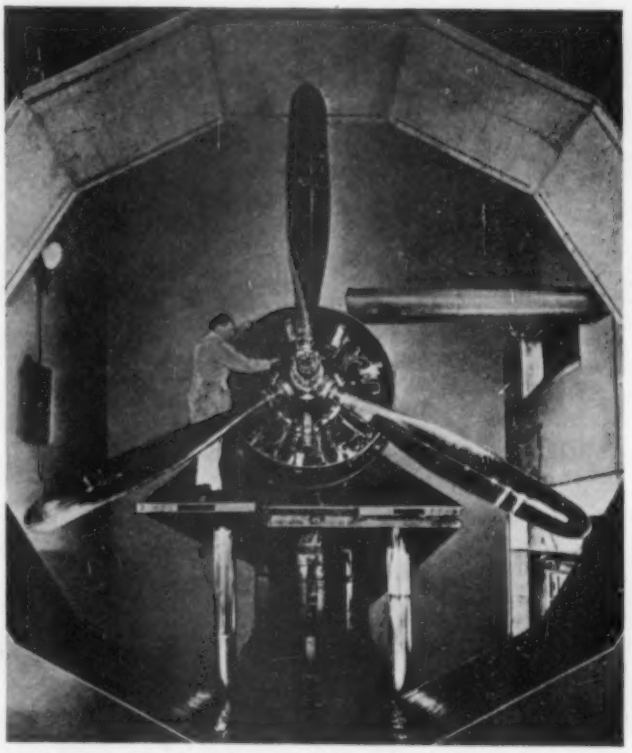


Fig. 2—Three-Blade Hollow Steel Propeller, 16 Ft. 6 In. Diameter

Manufacturing Procedure

Curtiss hollow steel blades are assembled entirely through the welding together of two component parts: the camber or curved plate which is rolled up in one end to form the shank, and the thrust or flat plate. The raw material is S.A.E. alloy steel plates. A rough outline of the main operations follows:

(*a*) Mill plates.
(*b*) Blank.
(*c*) Form.
(*d*) Weld edges.
(*e*) Weld shank seam outside.
(*f*) Round shank.
(*g*) Weld cuff retaining ring.
(*h*) Weld shank seam inside.
(*i*) Upset shank.
(*j*) Braze inside edge fillets.
(*k*) Heat treat.
(*l*) Finish and balance.

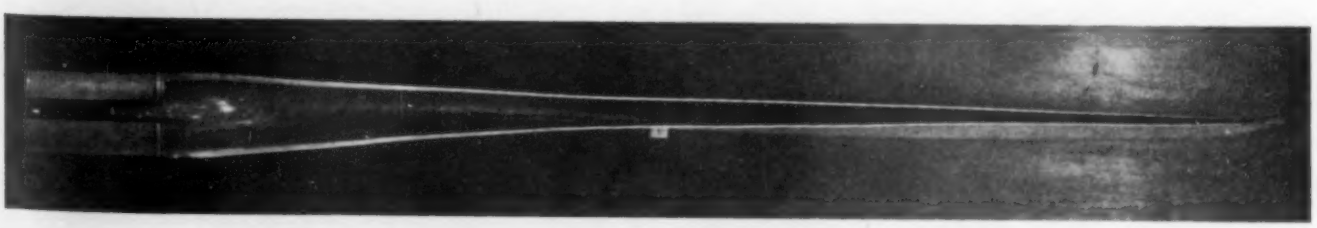


Fig. 1—Curtiss Electric Propeller Blade Longitudinally Sectioned*

* Presented at the Annual Meeting, A.W.S., Cleveland, Ohio, Oct. 12 to 15, 1942.

† Chief Metallurgist, Curtiss Propeller Division, Curtiss-Wright Corporation, Beaver, Pa.

* Photography by Warren E. Gottschalk, chief photographer, metallurgical department, Curtiss-Wright Corporation, Curtiss Propeller Division, Beaver, Pa.

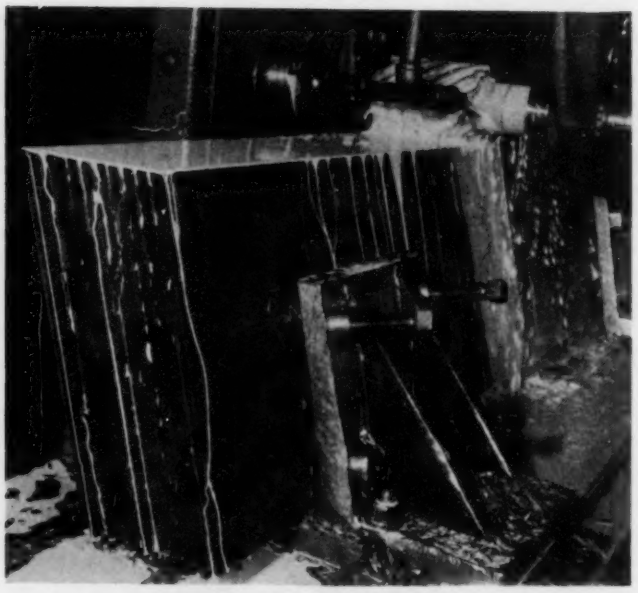


Fig. 3—Edge Milling Operation

The finished blades are heat treated to a Rockwell hardness of C26 to C33. The physical properties of the steel after the standard 1650° F. quench and 1170° F. draw are given in Table 1.

Table 1—Static Mechanical Properties of Steel Used in Steel Blades

	Virgin Steel*	Weld Metal*
Ultimate tensile strength	135–165,000 psi.	115–130,000 psi.
Yield point	125–160,000 psi.	95–110,000 psi.
Reduction area	45–60%	45–65%
Elongation	15–20%	15–20%
Endurance limit	75,000 psi.	50,000 psi.
Hardness, Rockwell	C 26–C 33	C 21–C 25

* Polished specimens.

Raw Material and Preparation

The camber plates, or camber shells according to shop terminology, are shaped from rolled and annealed plates of about $^{9}/_{16}$ in. thickness. The length and width vary in accordance with the design of the blade being made. In the first machining operation, the plates are placed in batches of about twelve in a milling machine fixture holding them on edge at an angle of 15° from the vertical direction (see Fig. 3). Both longitudinal edges are milled to give exact plate width in addition to beveled edges. The second operation consists of straight grinding or milling of one face to remove decarburization and surface imperfections. The plates then are "broken down" at the shank end to keep the shank part clear of the milling cutter in following machining operations. Subsequently, they are taper milled so as to be thinned out toward the tip. Next, the edges are notched to permit a breakdown of the longitudinal edges, prior to the finish milling, which operation is shown in Fig. 4. Together, these two last operations create a plate with one dished and one flat surface, and thickened edges (see Fig. 5). The camber shells then are blanked and put through a number of cold forming and final trimming operations.

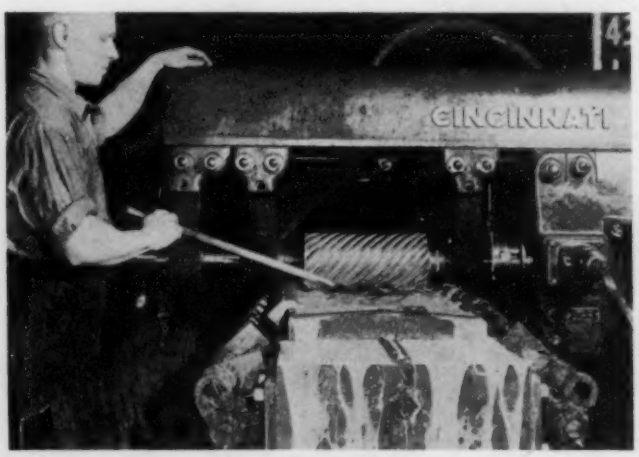


Fig. 4—Finish Milling

The thrust plates are milled, blanked, formed and trimmed, in a sequence similar to that employed in the shaping of the camber shells. Cambers and thrusts subsequently are paired and weighed. Before the plates are set up in a welding jig, filler beads are welded on the inside edge at the outboard end of the so-called turnover sections of the camber plate, as indicated in Fig. 6.

Welding Operations

Three different welding methods are employed in the present manufacturing scheme:

Fig. 5—Finish Milled Camber Plate

Atomic hydrogen arc welding for the edges.

Unionmelt welding for the outside shank seam and the cuff retaining ring.

Oxyacetylene gas welding for the inside shank seam.

The camber shell is placed on the base casting of the welding jig as shown in Fig. 7; a mandrel is inserted between camber and thrust plates and the latter plate is fitted on top of the assembly, whereupon the head is screwed down. The setup is carefully checked by the Inspection Department and approved only after any necessary adjustments have been completed, and the plates have reached the specified preheating temperature of 400° F.

The welding is performed by two operators working simultaneously, one of whom starts at the tip and the other at the base of the "Y" or crotch, at the inboard end of the thrust plate. (Refer back to Fig. 6.)

Figure 8 shows an operator in action.

Figure 9 shows a completed blade sectioned at typical stations; the sections are etched to show the welds.

Different welding techniques are used at the turnover sections and along the lead and trail edges. The amperage varies in accordance with the thickness of the section

between 15 and 50 amp.; the hydrogen pressure is maintained at about 4 to 7 lb. per sq. in. depending on the orifice of the torch.

Along the turnovers, the metal varies in thickness between $^1/_2$ and $^1/_4$ in. depending on the distance from the shank. The plates are set up in a manner such that a V notch is formed between the two plate edges. The gap is $^1/_8$ in. wide at the root and about $^3/_8$ in. at the top. The plates first are tied in at the root and subsequently the rest of the gap is filled with welding rod. From the turnover to the tip, the plate thickness varies from $^1/_4$ in. to about 0.060 in.

On the leading edge, the camber plate is built up along the future bond line under deposition of one to three "filler beads" depending on the depth of the gap, and the thrust plate edge then is tied in to the built-up camber edge, whereupon the rest of the gap is filled with rod.

Along the trailing edge, the thrust plate is tied directly to the camber plate under simultaneous deposition of rod. The rest of the edge then is filled with rod to give proper contour. The blade is removed from the jig after the mandrel has been withdrawn.

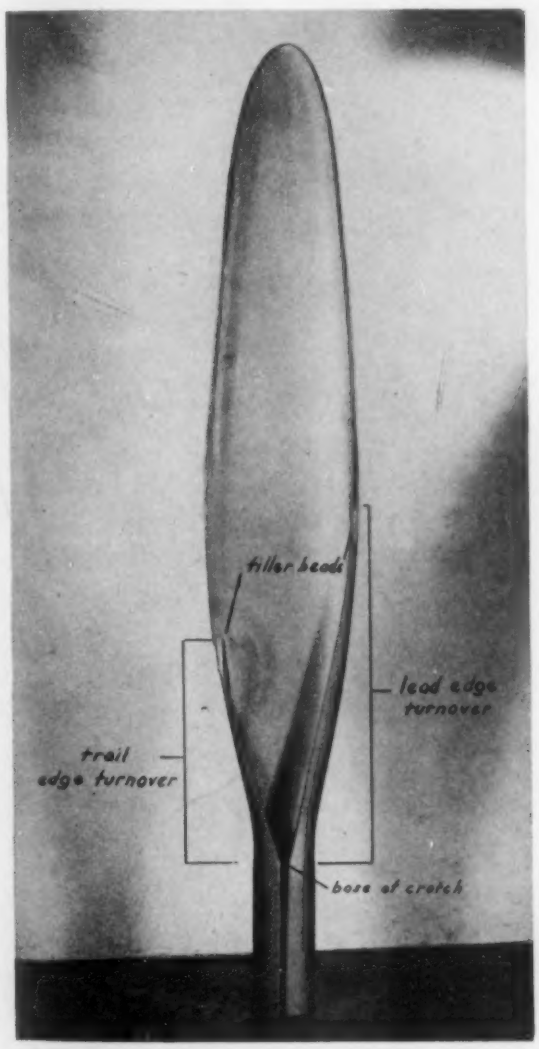


Fig. 6—Finish Formed Camber Plate

Figure 10 is a close-up of atomic hydrogen welding and, in addition, shows the torch.

The blade next is transferred to the Unionmelt Welding Department for welding of the outside shank seam. This operation, which is illustrated by Fig. 11, is fully

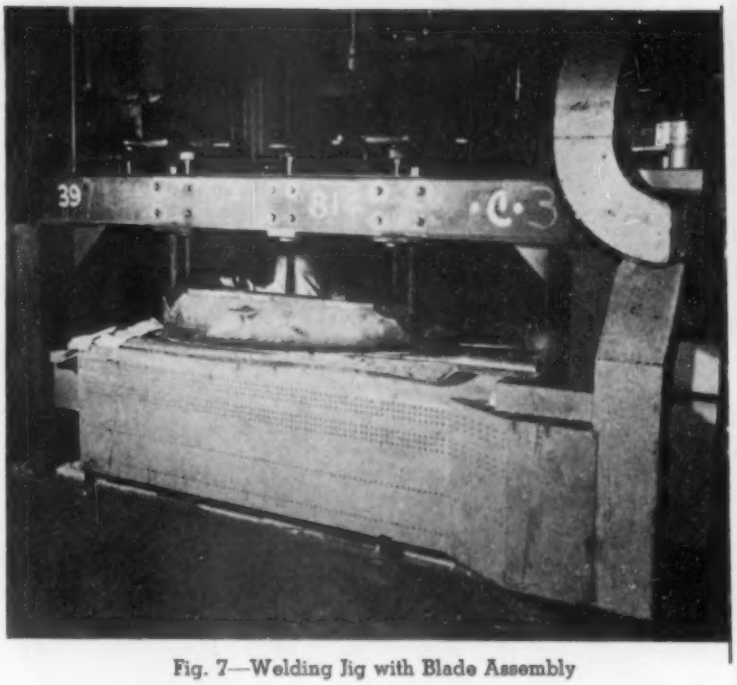


Fig. 7—Welding Jig with Blade Assembly

automatic. The rod, $^1/_4$ in. in diameter, is mechanically reeled off from a coil. A backing of Unionmelt compound is used on the inside of the shank. The slag-making compound covering the weld melt is gravity fed from a hopper and is confined to the surroundings of the seam by a dam made from heavy sheet steel. The amperage is 720, and the voltage 30. Top production is about 100 shank seams per 8-hr. shift per unit.

Following outside seam welding, the blade is stress relieved at 1200° F., excess weld metal is removed, the edges are radius ground to template fit, and the welds X-rayed; the blade then is moved to the Forge Press Department where the shank is heated in an induction coil, rounded in a series of split dies and then buried in flake mica for slow cooling.

The next operation consists of welding the cuff retaining ring whose ultimate purpose is implied by its name, but whose immediate purpose is to serve as a backstop during upsetting of the shank. Again, Unionmelt welding is employed with a setup illustrated by Fig. 12. The rod is $^1/_8$ in. in diameter, the amperage 300, at about 25 volts, and the speed is $^3/_4$ r.p.m. The ring is four beads high and its maximum width also is four beads. After welding, the shank is buried in flake mica contained in a

Fig. 8—Atomic Hydrogen Welder in Action

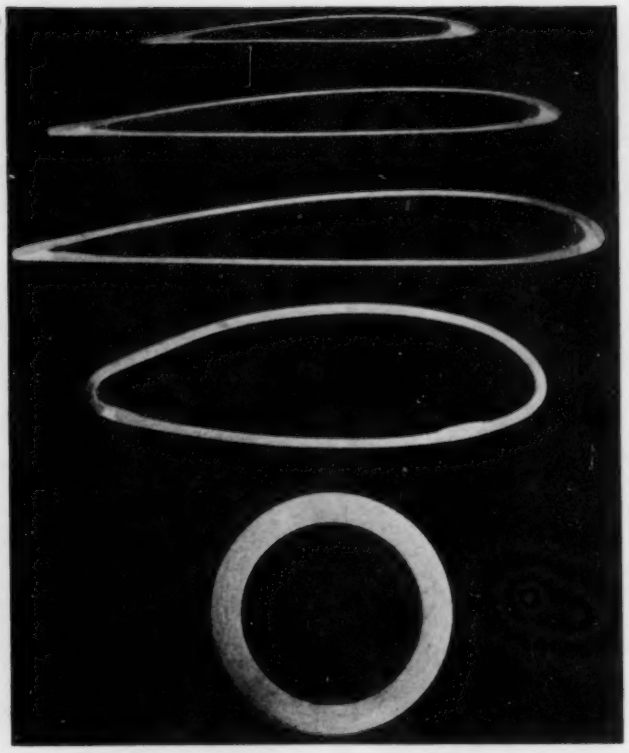


Fig. 9—Typical Propeller Blade Sections

box on wheels; the box is rolled to the Inside Seam Welding Department, and the blade is transferred to the welding jig directly from the mica box.

The purpose of the inside seam weld is to fill out that part of the gap which has not been fully reached by the outside seam weld, and to smooth out the weld surfaces on the inside up to the end of the turnovers. The small work space inside the blade necessitates the use of an acetylene torch, cooled by a water jacket. Figure 13 shows an inside seam welder at work and his torch partly can be seen. The preheating temperature must be high to promote smooth metal flow and prevent sooting. After completed welding, the blade again is mica box cooled.

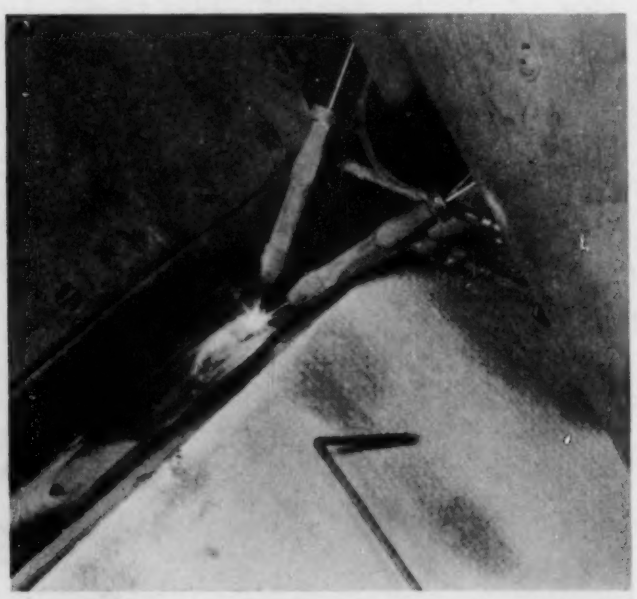


Fig. 10—Close-Up of Atomic Hydrogen Welding; Part of Torch Can Be Seen

The welding of the blade now is completed, and the shank and ring are turned and X-rayed in preparation for shank upsetting, which operation is preceded by a second heating process in an induction coil. The upsetting is followed by outside shot blasting and polishing of the edges and shank seam to facilitate magnaflux inspection prior to brazing of the inside edge fillets.

The purpose of the fillets is to relieve stress concentrations that may arise on the inside of the blade edges because of eventual sharp corners. The occurrence of such corners cannot be controlled completely since the blade from the end of the turnover sections to the tip is welded only from the outside. In that part of the blade edges, copper wires are inserted and melted down through the gradual passage of one edge at a time between two pairs of oppositely located and insulated gas burners. The operation and equipment are shown in Fig. 14. Before brazing can be begun, the blades are stress relieved, and after inside and outside shot blasting, they are heated with steam from a flash boiler, pickled inside with 50% muriatic acid, steam cleaned, dried with compressed

Fig. 11—Outside Shank Seam Welding by the Unionmelt Process

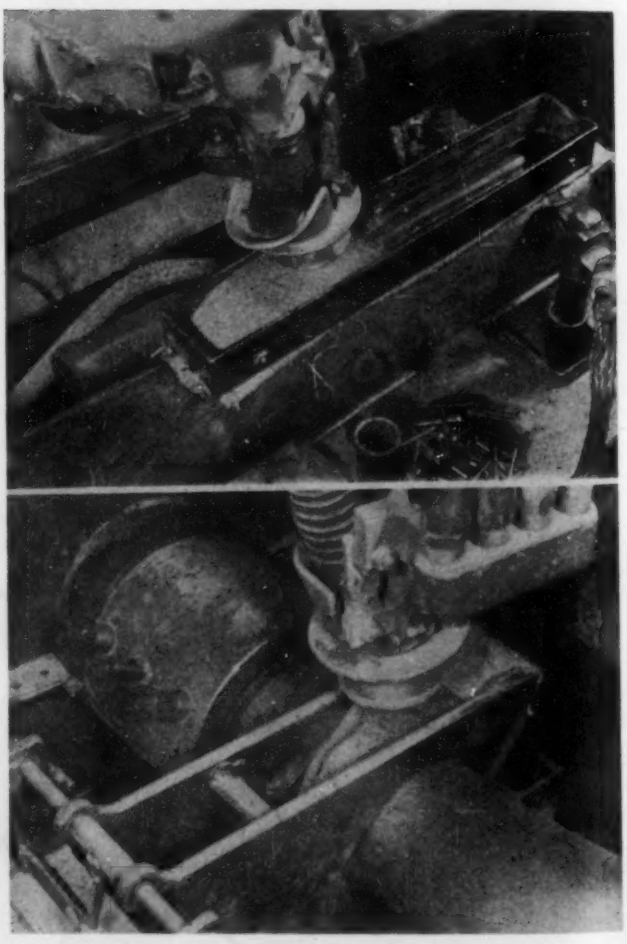


Fig. 12—Unionmelt Welding of Cuff Retaining Ring

air and fluxed along the inside edges. The filleting metal presently used is O.F.H.C. copper.

After brazing, the blade again is X-rayed and magnafluxed to check the condition of the edge fillets. The structure of the steel then is rendered uniform and fine-grained through normalizing. The edges subsequently are polished to permit close inspection prior to hardening.

Heat-Treating Operations

Heating for hardening is performed in the same type of furnace and atmosphere as used for normalizing, each blade being placed in an individual nichrome muffle. The atmosphere is generated through combustion of a 6 : 1 mixture of air and natural gas. Water vapor and carbon dioxide are removed, and the final product contains 6 to 8% CO, 10 to 12% H_2, no CO_2 and a trace of H_2O. Its dewpoint is about −20° C. or less.

Final straightening is accomplished in conjunction with hardening in a die with an internally applied nitrogen gas pressure. The die shoes are water cooled internally. The die hardens the thin sections of the blade, but the application of external quench water is required in the shank end. Figure 15 shows a blade being removed from the furnace, Fig. 16 is a view of the shank end of the die. The as-quenched hardness of the steel is Rockwell C46 to 52; after tempering at 1170° F., the base metal will have a hardness of C26 to 33, the somewhat softer weld metal, C21 to 25. Hardness checks are performed on the shank end after removal of decarburization through spot milling. The tensile properties will be as previously shown in Table 1.

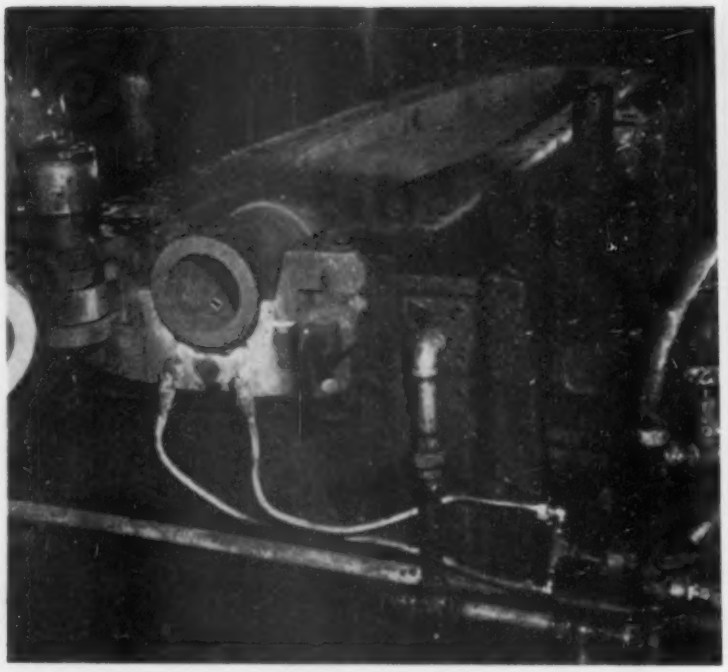


Fig. 16—Shank End View of Straightening Die

Fig. 13—Inside Seam Welder at Work. Note Long Water-Jacketed Torch

Finishing and Inspection

The blade after heat treating proceeds through a number of mechanical and inspection operations, such as shot blasting of inside and outside, grinding and polishing, weighing, balancing, finish-turning and grinding of shank, inside threading of the shank, finish balancing, and applying the surface finish: in connection with these

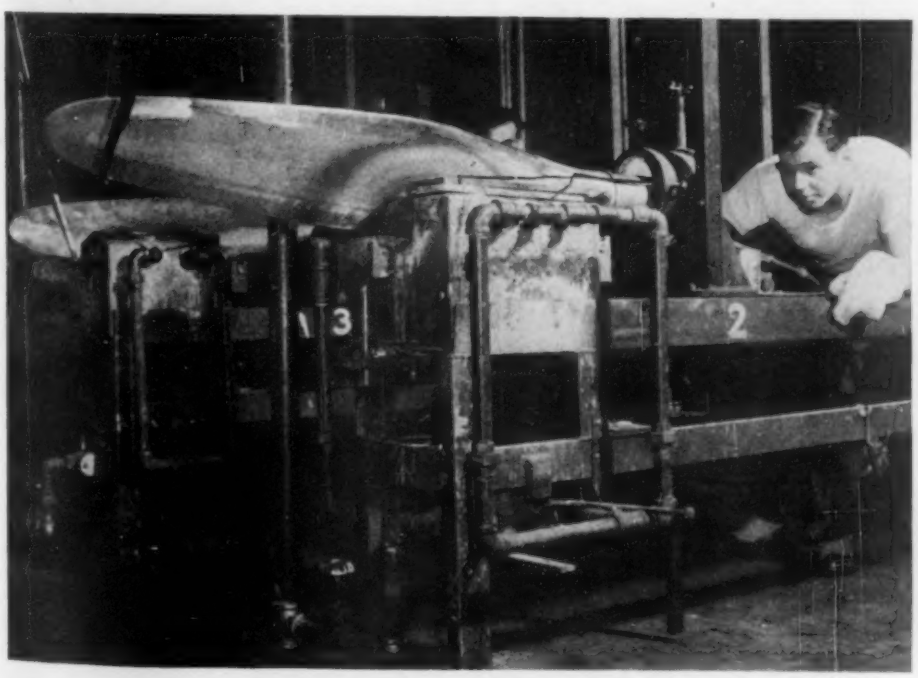
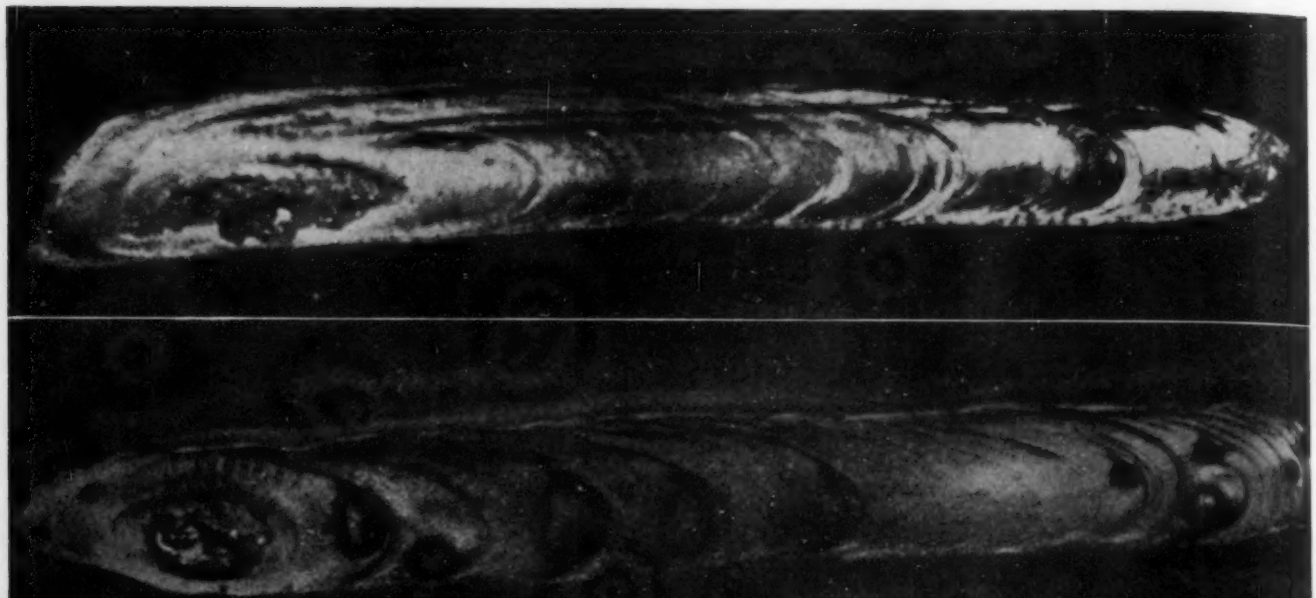


Fig. 14—Brazing of Edge Fillets

Fig. 15—Removal of Blade from Hardening Furnace

Fig. 17—Fusion Test Results on Steel of Good Weldability



Photos courtesy Battelle Memorial Institute

Fig. 18—Fusion Test Results on Steel of Poor Weldability

operations, it receives an X-ray and four magnaflux inspections. In all, the blade is magnafluxed six times after completion of welding. There is a total of 38 inspection operations of the assembled blade.

Atomic Hydrogen Welding in Blade Manufacture

Experience with the atomic hydrogen arc welding method in making steel blades has shown that this type of welding is extremely sensitive to steel quality. This sensitivity is brought out in a striking manner by the fusion test, which test permits differentiation between heats that are and are not suitable for the economic production of hollow steel blades by atomic welding. Figures 17 and 18 show the results of fusion tests on a good and a bad heat. The introduction of the fusion test in 1936 was questioned by the steel suppliers on the grounds that it was arbitrary and too much dependent upon personal opinion; but subsequent experience has proved its value. Present views can be summarized as follows:

1. The necessity of selecting steel through the fusion test is conceded. It is possible to produce sound blades from steel rejected by this test, but production is slowed down excessively because it is necessary to allow the operators much additional welding time to "wash out" gas, and excessive decarburization results from the prolonged exposure of the metal to the atomic hydrogen atmosphere.

2. Blades can be welded by the metal arc process from steel rejected for atomic hydrogen welding, but

Fig. 19—Radiograph Showing Inside Contour of Atomic Hydrogen-Welded Blade

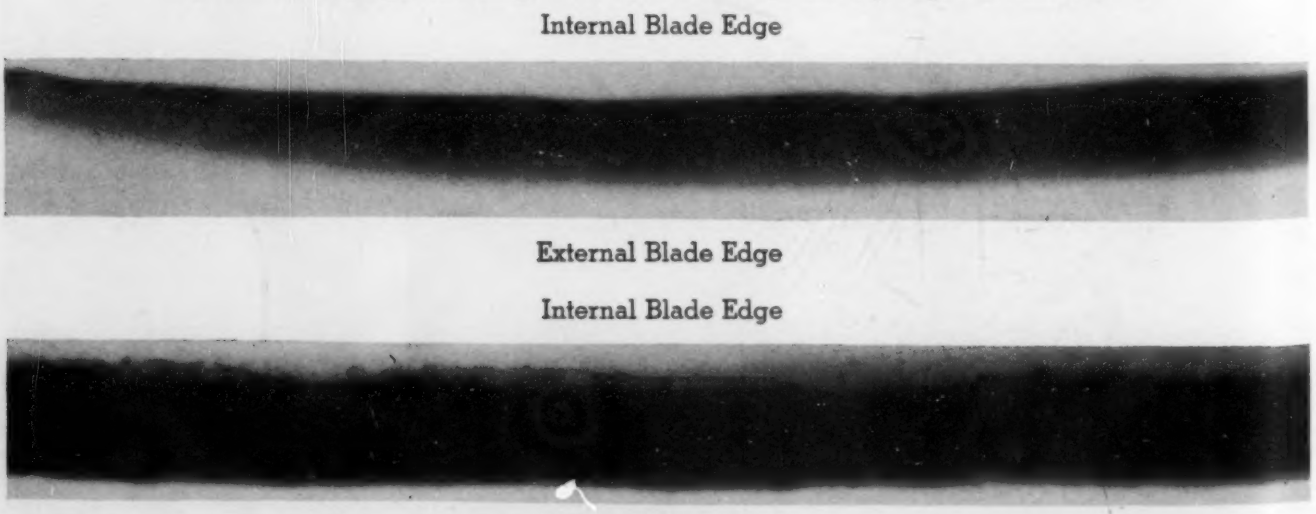


Fig. 20—Radiograph Showing Inside Contour of Metallic Arc-Welded Blade

Table 2—Propeller Steel Melting Results for July 1942

Vendor	Total Heats	Rejected Heats	Rejections, %
A	92	0	0
B	69	3	4.3
C	44	4	9.1
D	28	1	3.6
E	42	2	4.8

the control of the inside contours of the weld is not as good as with the atomic hydrogen process.

3. The main factor affecting weldability is thought to be the sulphur content of steel.

Five steel sources recently have been producing blade steel for the Curtiss Propeller Division, and all of them have developed methods for the production of acceptable steel with more or less satisfactory regularity. Table 2 shows the melting results for the five vendors for July 1942.

The main advantages of the atomic hydrogen process arise from its cleanliness. Because of the negligible amount of slag, the weld melt at all times is fully visible to the operator and, therefore, accurate control of the results can be maintained with comparative ease. Because uncoated rod is used and the hydrogen atmosphere readily reduces the slight oxide film which may form after the flame has been removed, successive beads can be deposited without intermediate brushing or scraping. These circumstances make the atomic process a convenient and comparatively rapid production tool. In experiments with other welding methods, eleven blades were metallic arc welded. Seven of these blades were welded by two exceptionally skilled operators whose best welding time was about one-third more than the average atomic hydrogen welding time.

The possibility of controlling the inside contour of the welds with the atomic hydrogen method in comparison with metallic arc is indicated by the radiographs of Figs. 19 and 20. The superiority of the atomic hydrogen weld is apparent.

Results of Present Weldability Investigations on Blade Steel

In February 1942, the Curtiss Propeller Division after considerable research in conjunction with various steel mills initiated a project with the Battelle Memorial Institute for an investigation of the fundamental factors affecting the atomic hydrogen weldability of steel and the eventual development of effective control methods. The work conducted to date has indicated the dominant role of sulphur as a factor influencing gas evolution in the weld melt. In a group of 24 production heats, only one of 12 showing good weldability had more than 0.012% sulphur, while 8 of the 12 bad heats had a minimum of 0.015, a maximum of 0.021 and an average of 0.0175% sulphur. That sulphur alone did not run the show, however, was indicated by the fact that of four bad heats one contained only 0.007, one 0.008 and two 0.009% sulphur. Part of the answer, at least, was found in the deoxidation practice. Aluminum additions were found to determine the type of sulphide inclusions formed in a series of experimental heats. No aluminum resulted in the formation of rounded sulphides of low plasticity; just enough aluminum to reduce FeO, MnO, and SiO_2, resulted in the formation of so-called eutectic sulphides constituting films or envelopes of minute globules around primary crystals; an excess of aluminum resulted in the formation of crystalline or angular sulphides. Examples of these types of inclusions, designated Types I, II and

Photos courtesy of Battelle Memorial Institute

Fig. 21 (Top)—Type I Sulphide Inclusions. No Aluminum Addition

Fig. 22 (Center)—Type II Sulphide Inclusions. So-called Eutectic Type. Aluminum Addition Just Large Enough to Reduce All FeO, MnO and SiO_2

Fig. 23 (Bottom)—Type III Sulphide Inclusions. Excess of Aluminum Added

III, respectively, are shown in Figs. 21, 22, and 23. In the medium sulphur steels, it was concluded that Type II inclusions most frequently were associated with steel of low weldability.

The study of these factors is continuing, and it is hoped that the understanding of factors influencing atomic hydrogen weldability will be further advanced. At present, attempts are being made to find a correlation between crack sensitivity and atomic hydrogen weldability.

Material Specifications and Testing of Blade Steel

The writing of material specifications for blade steel has been governed by past experience in the manufacture, testing and performance of hollow steel blades. The ability of the steel to develop the necessary strength and ductility through adopted standard heat treatments, its capability of withstanding production cold forming operations, and freedom from macroscopic defects are major requirements. The policy of the Curtiss Propeller Division with respect to off analysis heats has been liberal. Heats showing comparatively wide deviations in chemical analysis have been accepted with few exceptions when the physical requirements have been met.

The testing procedure, on the other hand, is exacting. Test coupons representing a melting heat are submitted shortly after the melting of a heat, for testing of chemical analysis, weldability, tensile properties, impact strength, grain size and hardenability. If the requirements are not met, the heat is rejected and is not further processed into blade steel by the steel mill. This procedure calls for speedy testing methods, and all results usually are reported no later than 48 hours after the coupons have been received. With respect to physical testing, the program presents no difficulties, but when sometimes as many as 40 coupons are received at once, speedy chemical analysis methods are required. A good solution has been found in spectrochemical analysis. One spectroscopist without difficulty can perform that many determinations of Mn, Si, Cr, V, Ni and Mo in 8 hr. Three chemists run the required number of carbon, sulphur and phosphorous determinations. The spectrochemical results usually are found correct within plus or minus 2% of the element contained.

Summary

Fabrication by welding of so critical a product as hollow steel blades made from tapered and formed plates has been accomplished through the application of these principles:

1. Adaptation of the design to the physical properties of the weld.
2. Careful selection of raw materials.
3. Advanced manufacturing methods.
4. Rigid production and inspection control.

These blades have proved successful in service. Their manufacture in quantities approaching mass production is a notable contribution to our war effort.

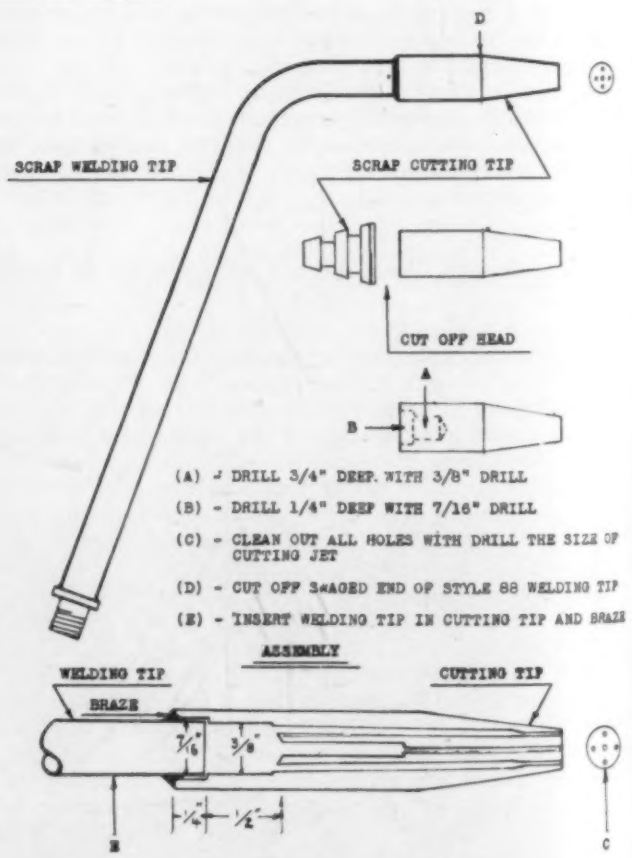
The "Victory" Heating Tip

By A. W. Flint*

AS an aid toward the conservation of precious metals, such as copper, brass, etc., we have developed a method of salvaging old cutting tips of which the seats have been damaged, and old welding tips. This method embodies the joining of the two together after alterations to the cutting tip and produces a multiflame heating tip.

We have found that there are a number of advantages for this apparatus, such as providing a better heat transfer for the same gases burned, thus improving the efficiency of the tip. Time is also saved and less tip changes are necessary, because this tip, with minimum and maximum pressures, gives off a satisfactory flame, as it has a wider range of adjustment than a single-flame welding tip. A softer flame conducive to a soaking heat, or a surface heat, depending on torch manipulation, is obtained if this tip is used. Since the heat transfer loss is in the minority these tips are as efficient as a single-flame tip and the gas cost should be reduced from 15 to 30%. The multiflame tip is also faster on certain operations than the single-flame tip, and this, plus the savings made on the gas, is quite an economy, thus aiding our national conservation program.

We have also found that this apparatus can be employed for such applications as heating for straightening and shrinkage, such as spot heating, line heating, surface heating, etc. Also it can be used for heating in the forming of plate and structural shapes, and for flanging, laying up and fitting operations. Further, it is used on simple flame-hardening operations and in advance of specific cutting operations; likewise on certain brazing operations that require a fair size tip and in the copper shop when performing silver solder operations. Most brazing operations and all heating operations are much more satisfactory when accomplished with the multiflame tip.



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Adapting Automatic Electric Welding to Routine Production*

By J. M. Keir†

IN the rapid expansion within the last year of all types of metal-fabricating operations there have been many opportunities to apply the Unionmelt automatic electric welding process to a variety of structures, both large and small, and to steels of many different analyses. A substantial ground of experience has been built up so that it is now a simple matter to adapt the process and to work out the exact details of procedure for any new undertakings.

Those shops that have been using the process for several years have gained through experience a knowledge of how to handle the problems they encounter in their work. This paper may, therefore, be of only general interest to them. It was prepared primarily for the benefit of new and prospective users of the process, and will discuss such matters as the types of backing used in making Unionmelt welds, and the available grades of rod and the Unionmelt material itself with respect to their proper use. The discussion of types of installations used for various applications should also prove helpful to these users in adapting this welding process to routine production.

Types of Weld Backing

The Unionmelt process is similar to hand arc welding only in that an electrode in the form of a rod is fed by controlled means into the welding zone, and metal is discharged from the tip of this rod into the seam being welded. The condition that prevails in the immediate weld zone, however, requires a substantially different mechanical setup from that used in hand arc welding. This condition is caused by the unusually high currents used in Unionmelt welding. For example, when welding is being performed with a $^1/_4$-in. welding rod, the current may range from 700 to 1400 amp. This great input of heat results in a relatively large body of molten metal in the zone where the weld is being made. Because this metal is highly fluid and because rapid chilling does not occur, some means must necessarily be used to prevent the molten metal from falling through the bottom of the weld. The obvious step is to use some means of backing up the weld as it is being made.

Backing up is accomplished in several different ways, depending upon the thickness of the material being welded and also upon the physical shape of the job. The number of identical welds to be made must also be considered. Three general types of backing up are used:

1. Copper strips held in place temporarily and removed after the weld has been completed.
2. The use of a layer of Unionmelt granules held up under pressure to the underside of the weld.
3. The use of a steel strip tack welded by hand to the bottom surfaces of the two pieces to be joined.

A variation of this third method is the application of weld metal by hand welding methods to the underside of the vee, in sufficient bulk to retain the hot metal and prevent its burning through and escaping.

Perhaps the most common use of copper strips for backing is in pipe welding in which large numbers of long straight seams are made in extensive, repetitive operations. Here the expense of a suitable jig that will clamp the pipe firmly in place and hold the copper strip tightly to the underside of the weld is justified. It should be pointed out that the somewhat rougher appearance of the back of the weld that results from the use of copper strips is accepted by pipe inspectors. A general view of a jig of this type is shown in Fig. 1. Where such repetitive work is carried out it is also quite feasible economically to use the copper-strip principle of backing on the circumferential seams of pipe, in conjunction with an expanding ring arrangement.

The second method of backing up, in which a layer of Unionmelt granules is used for the backing medium, is shown in Fig. 2. If conditions are carefully controlled with this method a high percentage of the welded seams will have a small bead on the inside, smooth and suitable in contour, and highly acceptable for pipe-line work. With this method of Unionmelt backing no entirely satisfactory means has been developed for holding the layer on the inside of a circumferential pipe seam, although it has been done successfully in welding inside circumferential seams in the production of large cylindrical pressure vessels.

The use of a steel strip tack welded to the underside of the seam and the application of weld beads by hand may be considered to be in the same category, in that in each type fusion into the strip or into the hand-welded metal is required.

For certain types of structures no backing at all is used. In ship construction the popular and highly efficient method of making butt welds in ship plate is to butt the square-cut edges tightly together and make a first pass on one side of the plate so that it penetrates approximately halfway through, and then make a second pass on the other side. In this way the unwelded portion of the plate thickness acts as the backing-up medium for the first pass, while the second pass is backed up by the weld made by the first pass. This procedure produces good-quality welds at high speeds, and has established substantial economies in the huge shipbuilding program. It is practical to use this technique on plate up to about $^5/_8$ in. in thickness. Of course the edges must fit together accurately to prevent escape of the fluid metal. This type of joint is shown in Fig. 3.

In the manufacture of pressure vessels the use of any means of backing up has been almost universally elimi-

* Presented at the Annual Meeting, A.W.S., Cleveland, Ohio, October 14, 1942.

† The Linde Air Products Co., New York, N. Y.

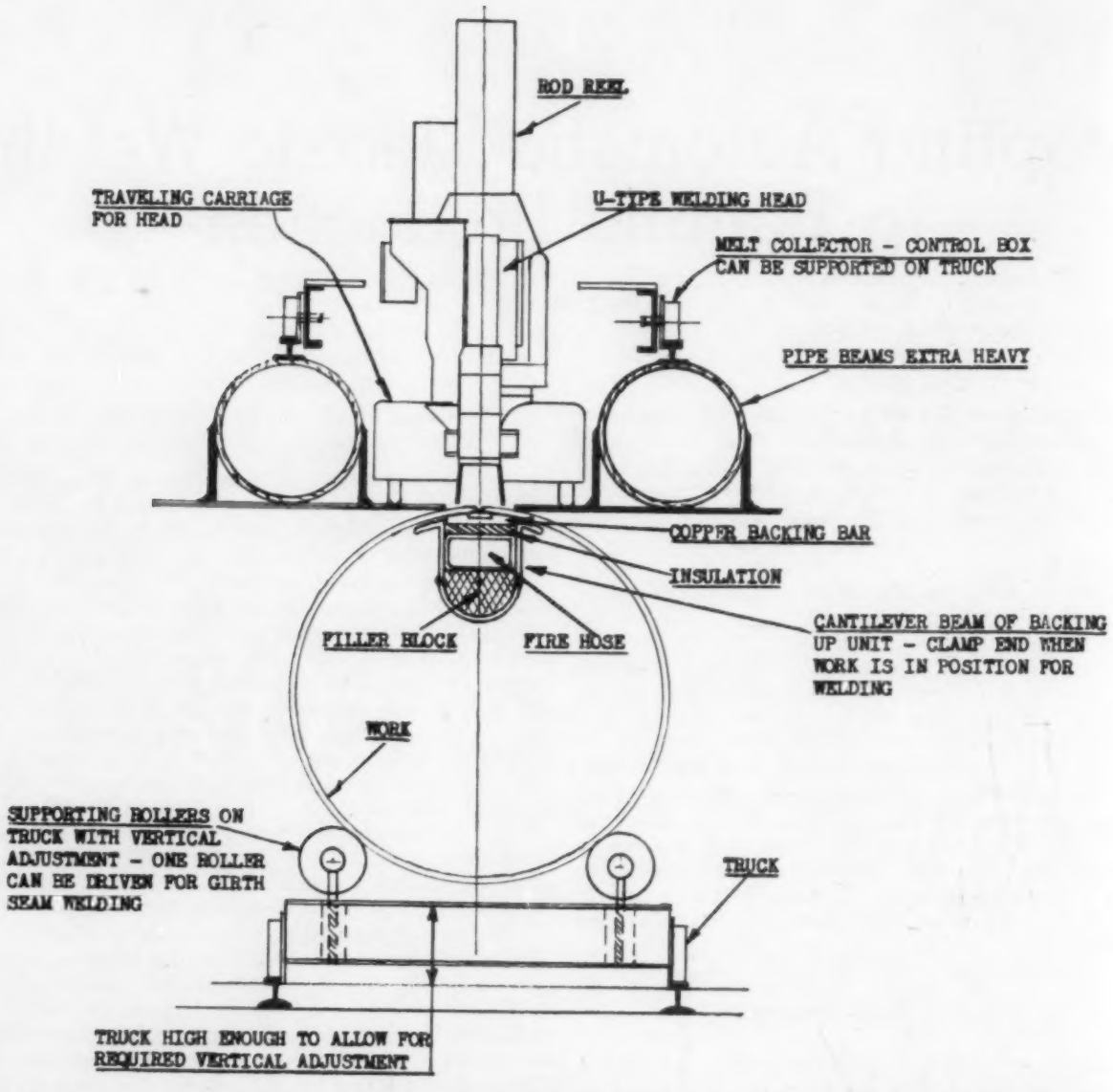

ROD REEL
TRAVELING CARRIAGE FOR HEAD
U-TYPE WELDING HEAD
MELT COLLECTOR - CONTROL BOX CAN BE SUPPORTED ON TRUCK
PIPE BEAMS EXTRA HEAVY
COPPER BACKING BAR
INSULATION
CANTILEVER BEAM OF BACKING UP UNIT - CLAMP END WHEN WORK IS IN POSITION FOR WELDING
FILLER BLOCK
FIRE HOSE
WORK
SUPPORTING ROLLERS ON TRUCK WITH VERTICAL ADJUSTMENT - ONE ROLLER CAN BE DRIVEN FOR GIRTH SEAM WELDING
TRUCK
TRUCK HIGH ENOUGH TO ALLOW FOR REQUIRED VERTICAL ADJUSTMENT

Fig. 1—Typical Pipe Welding Jig Showing Means for Clamping Edges of Joint Into Alignment

nated by the use of the double-vee method of edge preparation. A typical joint preparation of this type is shown in Fig. 4. The root face in the joint, it will be noticed, is of substantial dimensions. Welding conditions are so adjusted that the first-pass weld metal fuses approximately halfway through this face. As with the ship-construction joint, the first pass acts as the backing for the second pass. Large numbers of high-class pressure vessels have been and are being produced today with such double-vee joints. This design is particularly suitable for this purpose since there is not sufficient repetition to justify jigs and fixtures to accommodate the great range of diameters and lengths that would be necessary for single-pass work. Also these double-vee joints are more economical with respect to weld metal and power than are single-pass welds.

It is obvious that, in making a choice of the backing-up method, a number of factors should be taken into consideration, such as accuracy of fit, thickness of plate, number of joints to be made and general convenience in the shop that will do the work.

It might be added at this point that in single-pass work which is generally used in pipe line and other types of fabrication, it is necessary to remove the mill scale from the two adjoining surfaces on the bottom of the weld at all points where the fluid metal penetrates. Otherwise a reaction between the oxide and the carbon of the steel will result in the evolution of gases and cause porosity.

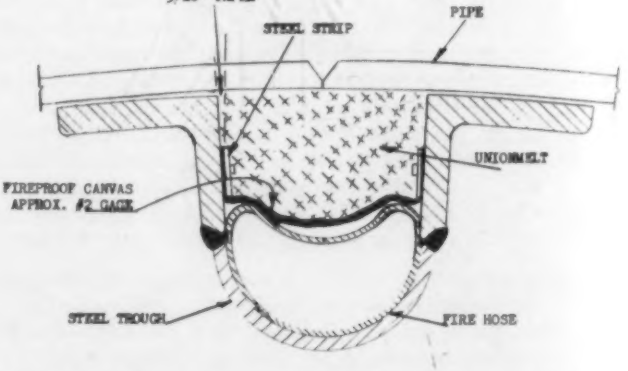


Fig. 2—Typical Detail of Unionmelt Backing Trough for Use of Pipe Welding Jigs, Etc.

Fig. 3—Square Butt Preparation for Double-Welded Plates Up to $^5/_8$ In. in Thickness. Largely Used in Ship Construction and Other Suitable Applications

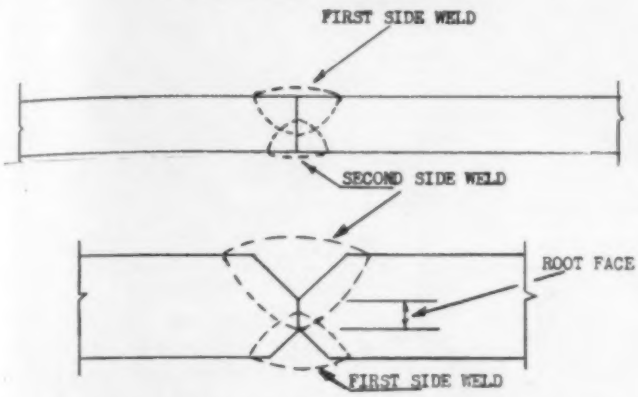


Fig. 4—Double-Vee Joint Preparation, Widely Used for High-Quality Welding for Plates $^1/_2$ In. and Greater

Selection of Grade of Welding Rod

Probably the next most important consideration in embarking upon the use of the Unionmelt process is the choice of the particular grade of welding rod that will be required. At the present time there are available three types of rod for welding plain carbon steels. Each of these types has less than 0.20 per cent carbon. The first produces about 0.60 per cent and the second about 0.90 per cent manganese in the weld deposit. These two types are appropriately selected for welding plate ranges of 50,000 to 60,000 psi., whereas the third type which is similar to the second but produces about 0.3 per cent molybdenum in the deposit, is used for steels ranging from 70,000 to 80,000 psi.

A noteworthy point to consider in selecting the type of rod for any one job is the fact that in the ordinary Unionmelt weld in plain carbon steel the mass of the base metal that is fused is $1^1/_2$ to 2 times that of the rod fused. It can be seen from this that the metal in the weld partakes largely of the composition of the plate. This greatly simplifies many of the problems that arise when an attempt is made to duplicate the composition and physical properties of the plate material.

As a result of the great volume of Unionmelt welding of armor plate of various kinds and grades for the Army and Navy, two special types of austenitic rod have been developed. One of these is more widely used because it has a lower percentage of the strategic alloys in its composition. There are also available special rods for welding corrosion-resisting alloys by the Unionmelt process. Since it is quite feasible to weld certain of the non-ferrous metals and alloys, such as nickel and Monel, rods for this purpose can also be made available.

Rod is commonly supplied in both small- and large-size coils, weighing 25 and 150 lb., respectively. Also, for one or two certain types of equipment, rod in most of the popular diameters is supplied in straight lengths, 16 ft. long.

Grades of Unionmelt and Their Uses

Since we are still discussing those conditions which have to deal with the actual welding in the seam, there is one other important material, the granular Unionmelt material itself, that has to be considered. There are three types of this material for welding. There is also a type which is of highly refractory composition that is suitable for use as a backing-up material.

The first type is the most widely used. It is suitable for a great range of plain carbon steel welding. The third type is generally used where much higher strengths are desired and also where plate of poor quality is encountered. The chief function of this latter grade is to preserve in the weld metal a somewhat higher proportion of manganese than is possible with the first type. It also has the characteristic of keeping the silicon in the weld metal low. For this reason it is more suitable for multi-pass welding than the first type. However, the third type when molten, is somewhat more fluid than the first type and consequently is a little more difficult to use on circumferential seams where the plate is thick and the diameter small.

The second type has characteristics similar to those of the third type but because of its lower fluidity is more suitable for circumferential seam welding operations.

Another point to consider when selecting the Unionmelt for a particular purpose is the size of the granules, since this physical condition affects the appearance and soundness of the weld as well as the penetration. Generally speaking fine granules produce a wider bead and less penetration than do coarse granules. They also produce smoother surfaces on the weld deposit. However, with dirty steel and general uncleanliness the coarser granules tend to give sounder welds.

The Unionmelt is normally prepared in four different mesh sizes, 8 x 200, 12 x 200, 20 x 200 and 20 x D. This means of identification indicates that, with the 8- x 200-size, for example, almost no material will remain on an 8-mesh screen, and, that only a small amount of the material will pass through a 200-mesh screen. The designation 20 x D means that almost no material will

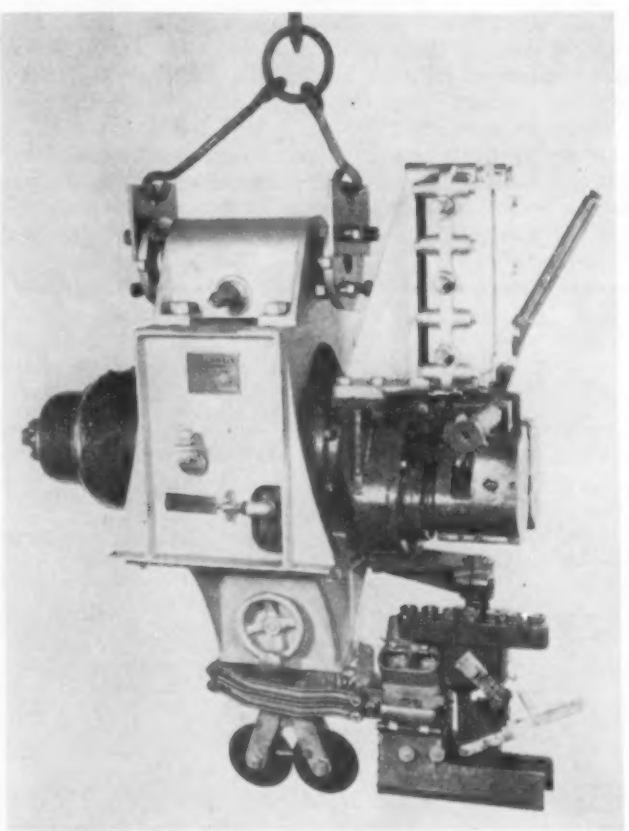


Fig. 5—The Type M Unionmelt Welding Head Is a Large Size Especially Useful for Heavy Welding

Table 1

Current Ranges, Amp.	Unionmelt Grades and Sizes Type No. 1	Type No. 2	Type No. 3
Up to 600	8 x 200,* 12 x 200	(Not recommended)	12 x 200,* 20 x D†
600 to 800	12 x 200,* 8 x 200, 20 x D†	8 x D	12 x 200,* 20 x D†
800 to 1100	12 x 200,* 20 x 200, 20 x D†	12 x 200	12 x 200,* 20 x D†
1100 to 1750	20 x 200,* 12 x 200, 20 x D†,‡	20 x 200	20 x D
Over 1750	20 x D	20 x D	20 x D

* Preferred size (except for heavy fillet welding).
† 20 x D size gives smoother welds, less tendency to undercutting, quieter action, wider surface, reduced penetration.
‡ Preferred for heavy fillet welding and plug welding.

remain on a 20-mesh screen, and that there will be a graduated sizing down to and including impalpable material of a dust-like fineness.

Generally speaking, the 8- x 200-size material is used with currents of up to about 750 amp. and $^3/_{16}$- or $^1/_4$-in. rods, for high-speed welding of plate up to about $^5/_{16}$ in. in thickness. The 12 x 200 material is usually used with currents of from 800 to 1300 amp. and $^1/_4$-in. rod, on plate ranging from $^3/_8$ in. up to about $^3/_4$-in. thickness, for single-pass work. The 20 x 200 material is used with currents of from 1300 amp. up to about 1750 amp. and $^3/_{16}$-in. rod, for welds on one side of double-vee joints in plate from about $1^1/_4$ in. to 2 in. in thickness. The 20 x D is suitable for currents ranging from 1700 amp. up to 2500 amp. with $^3/_8$-in. welding rod. These statements are general in character and should not be regarded as definite limitations, but the prospective user should be guided by the data in Tables 1 and 2.

Radical departures from these stated conditions are sometimes resorted to in special applications where unusual materials and unusual joint designs are encountered.

Assuming that we have selected the means of backing up and that we know the nature of the material to be welded, we can then select a proper combination of rod and Unionmelt for a particular job. There will be found in Table 2 a guide to this selection based on the above general information.

If an entirely new type of job is encountered which has some unusual features connected with it, it is always better to make some preliminary tests to determine definitely whether a rod of slightly different diameter, a different mesh or grade of Unionmelt, or a different bevel preparation and welding conditions will favor the making of the joint. This method is used extensively on new undertakings and is the proper basis of procedure to obtain the best solution. It may be found that changing the diameter of the rod will substantially alter the amount of penetration and the shape of the reinforcement if conditions are severely restricted. Also the grade and mesh of Unionmelt under critical conditions can vitally alter the quality and the amount of penetration obtainable with any definite power input. This is an important feature where restricted conditions are encountered or where only a certain amount of reinforcement is permissible to prevent interference with other parts of the structure.

Three Types of Welding Heads

The next important feature to be considered is the type of welding-head equipment that is available for feeding the rod into the seam. There are three automatic heads available, known as types M, U and S. The Type M-head, which weighs about 400 lb., will feed rod ranging from $^1/_8$ to $^1/_2$ in. in diameter. It will straighten and feed $^1/_2$-in. rod, for example, at the speed of 40 to 50 in. per minute. Its use is somewhat restricted because of its size and heavy construction, but it is indispensable where heavy seam and chain welding is to be carried out.

By far the most widely useful of Unionmelt heads is the Type U which will feed rods ranging from $^1/_{16}$ in. up

Table 2

Spec. No.	Plate Material	Rod Type No.	Unionmelt Type No.
A.S.T.M. A-7	Steel for bridges	2	1
A.S.T.M. A-9	Steel for buildings	2	1
A.S.T.M. A-70 S-1	Carbon-steel plates for boilers and other pressure vessels	1, 2	1, 2, 3
A.S.T.M. A-89 S-2	Steel plates of flange and firebox qualities for forge welding	1, 2	1, 2, 3
S-4	Seamless-steel drum forgings—Grade 1	1, 2	1, 2, 3
A.S.T.M. A-89 S-4	Seamless-steel drum forgings—Grade 2	2, 3	1, 2, 3
A.S.T.M. A-53 S-18	Welded and seamless-steel pipe	1, 2	2, 3
A.S.T.M. A-129 S-25	Open-hearth iron plates of flange quality	1, 2	1, 2, 3
A.S.T.M. A-131	Structural steel for ships	2	1
A.S.T.M. A-212 S-55	High-tensile-strength carbon-steel plates for pressure vessels (plates 2 in. and under in thickness)	3	1, 2, 3
A.S.T.M. A-202 S-28	Chrome-manganese-silicon (CMS) alloy steel plates for boiler and other pressure parts—Grade A	2, 3	1, 2, 3
A.S.T.M. A-201 S-42	Carbon-silicon steel plates of ordinary tensile-strength ranges for fusion-welded boilers and other pressure vessels	1, 2	1, 2, 3
A.S.T.M. A-203 S-43	Low-carbon-nickel steel plates for boilers and other pressure vessels—		
	Grade A	1, 2, 3	1, 2, 3
	Grade B	2, 3	1, 2, 3
	Grade C	2, 3	2, 3
A.S.T.M. A-204 S-44	Molybdenum-steel plates for boilers and other pressure vessels—		
	Grade A	1, 2, 3	1, 2, 3
	Grade B	2, 3	1, 2, 3
	Grade C	3	2, 3

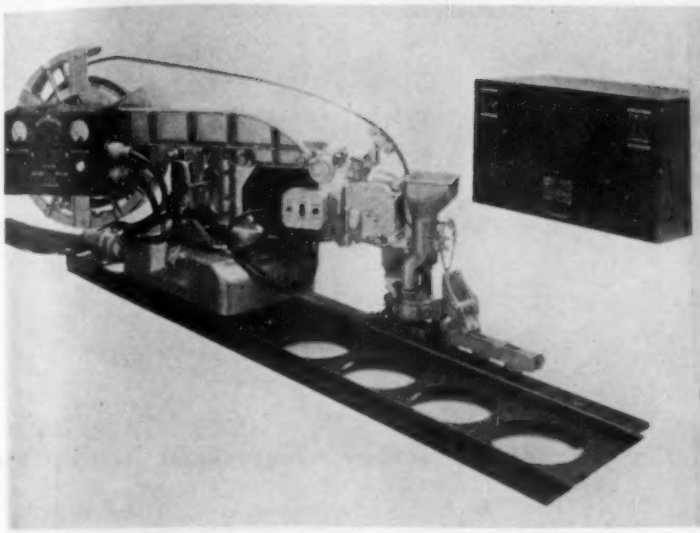


Fig. 6—The Type U Head and Rod Reel Form a Complete Welding Unit When Mounted on a Cutting Machine Carriage

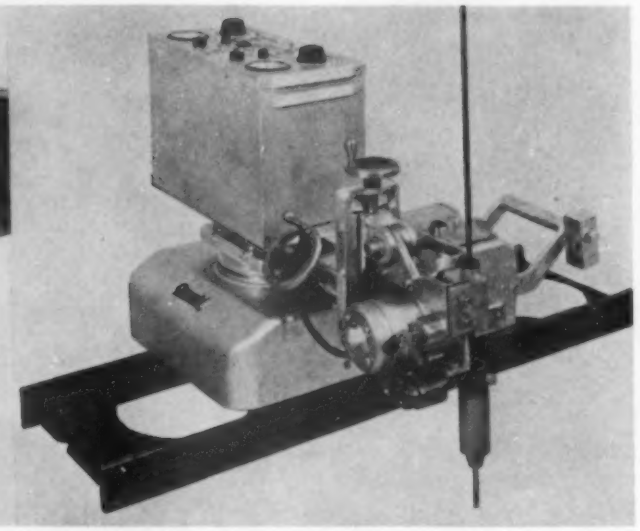


Fig. 7—The Type S Head Is Small and Readily Portable

to 5/16 in. in diameter, and may employ up to 2000 amp. This machine is small and compact in design and can be readily used in restricted spaces where the M-head could not possibly be used. Its great usefulness is found in portable units for welding plates up to 1 in. in thickness in ship work and in fixed installations, such as pressure-vessel shops. It will weld material up to 2 1/4 in. in thickness where double-vee preparation is used.

The Type S-head is a smaller piece of equipment which, like the U-head, can be mounted on a portable carriage. It takes straight lengths of rod only, since it does not have the power or the straightening roller equipment to use coiled rod. Rod used ranges up to 1/4 in. in diameter and for average work one 16-ft. length is sufficient for a seam 8 to 10 ft. long. Its maximum current is 1000 amp., and it will therefore weld 1/2-in. plate in a single pass. The Type S-head is extensively used for depositing seal beads on ship decks, and for shop installations where lightness in weight and portability are important considerations. The machine, however, is not suitable for high-speed repetitive work where the time lost in changing the welding rod is a consideration.

Fig. 8—A Hand-Operated Unionmelt Welding Head for Making Plug Welds

All of the above equipment can be readily used for making plug welds at high speed. Such welding consists of filling up the punched hole in a lap joint, thus eliminating the need for riveting. There is also available for this plug-welding purpose a portable hand plug-welder which has been found convenient for plug welding under certain conditions (see Fig. 8).

A recent development is a hand-operated feeding mechanism for using long lengths of straight rod, and some highly satisfactory applications have been carried out (see Fig. 9). It is believed that this hand tool will be suitable for short lengths of butt and fillet welds where currents up to 1200 and 1400 amp. may be used. Rods, 5/16, 3/8 and 1/2 in. in diameter can be used for most of these purposes.

The general appearance of these various pieces of equipment is shown in Figs. 5, 6, 7, 8 and 9.

Typical Installations for Various Operations

The remaining feature which has not been discussed up to this time, and which is of great importance in the success of a Unionmelt installation, is the mechanical handling equipment upon which the welding head is mounted and upon which the pieces to be welded are placed. There seems to be a diversity of opinion regarding the most suitable type for certain applications. Nevertheless certain standard installations have been worked out for the commonest applications, and while they may vary in certain details they are fundamentally alike.

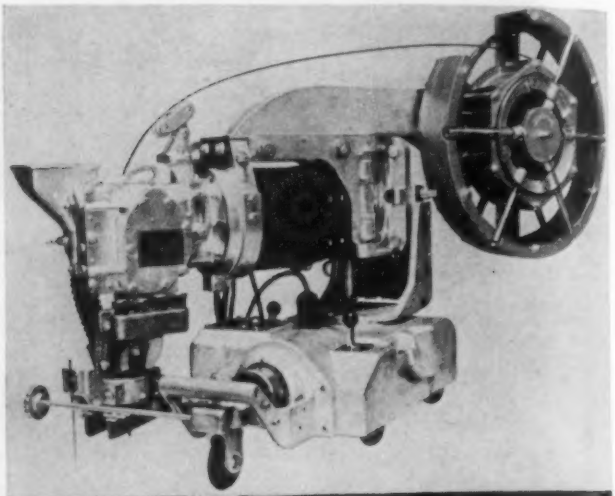
In shipbuilding almost all yards now using the Unionmelt process find the tractor unit shown in Fig. 6 an

Fig. 9—Type B Unionmelt Welding Head

almost indispensable piece of welding equipment. This machine propels itself on any flat surface and can be used for welding butt seams, and fillet seams with up to about a $^{3}/_{8}$-in. leg. Some operators prefer to operate this unit on a track which is set parallel with the seam, while other operators dispense with the track and use a hand-guiding device to keep the machine in the exact welding position over the seam (see Fig. 10). In the fabrication of water pipe, there seems to be general agreement that the standard type of power-operated jig which clamps both surfaces of the seam, with a copper backing-up strip underneath the weld, is the best and most practical method for producing straight-seam pipe (see Fig. 1).

In the earliest installations the general tendency was to use a gantry running on two tracks from which the welding head was suspended. This arrangement is quite suitable for the repetitive welding of long straight seams, such as those of railroad-car center sills (see Fig. 11). However, some of the later installations for center-sill welding make use of a head moving on its own carriage, which runs on a track supported in cantilever fashion from the columns or other structural members of a steel building.

Fig. 10—Type U Unionmelt Head with 5th-Wheel Guide, Operating Directly on the Work Without Track



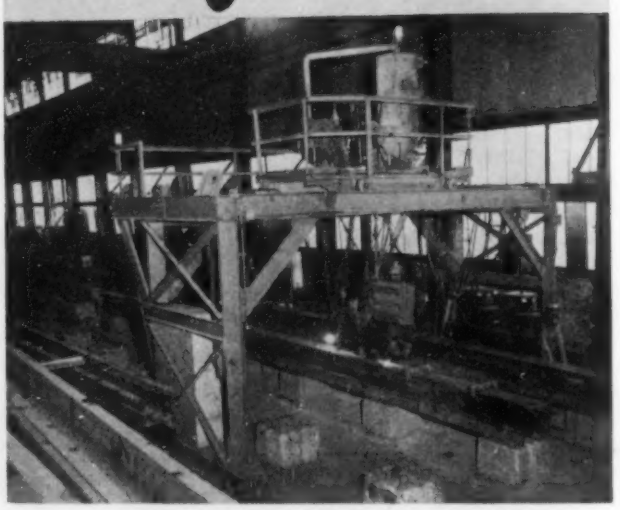


Fig. 11—Unionmelt Welding Installation in Which the Welding Head and Other Apparatus Are Carried by a Gantry Crane

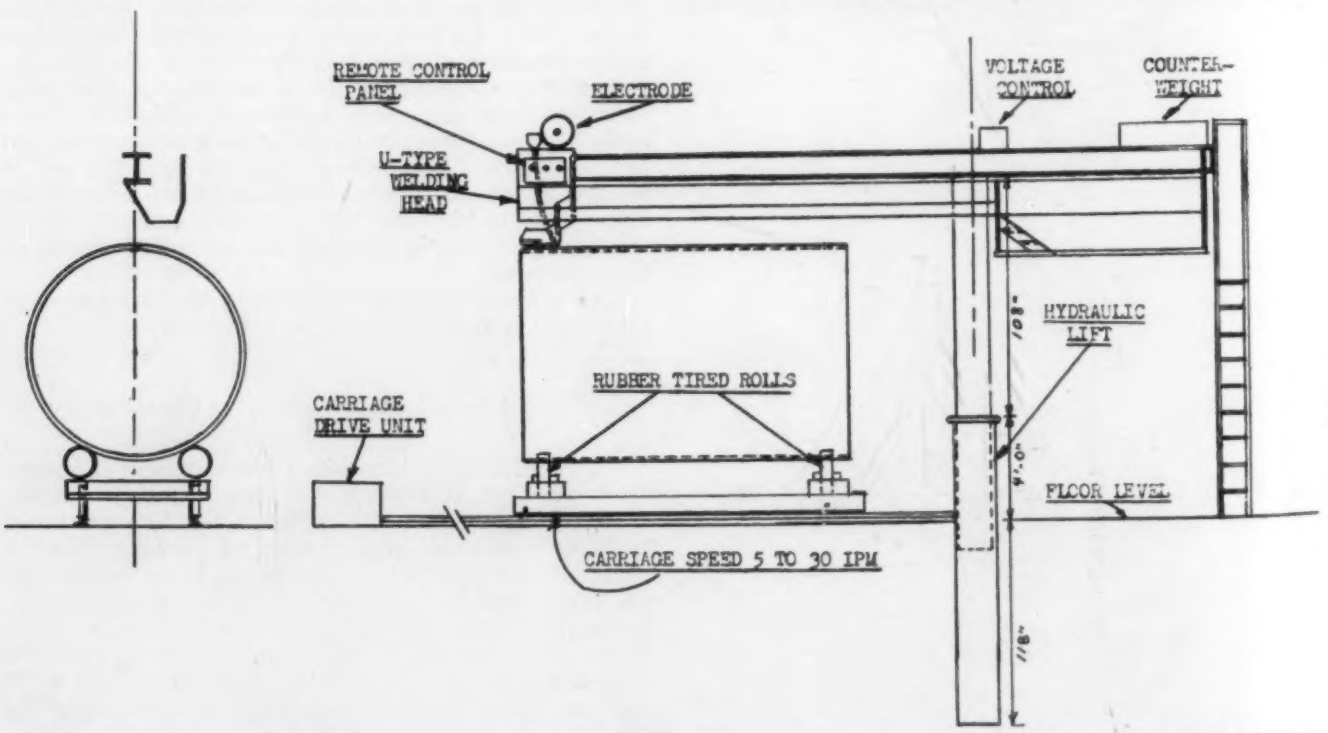


Fig. 12—Showing Basic Requirements of Pressure Vessel Installation Similar to Many That Are Being Used Today

There is also unanimity as to the setup of installations for pressure-vessel welding. These installations consist generally of a column based on a motor-driven carriage having a boom supported in cantilever fashion from the column; the Type U-head is attached to the end of the boom. With such an installation it is quite feasible to weld all the longitudinal and circumferential seams on the inside of a pressure vessel, and then to withdraw the boom and raise it the height of the shell and weld all the outside seams. Of course, no backing-up equipment is required with this procedure, since almost all the joints are of double-vee design. This type of setup has been adapted by a number of prominent pressure-vessel fabricators and has shown its worth in convenience of application and relative cheapness of installation. A typical installation of this nature is shown in Fig. 12. Although details differ from one shop to another, the general principle of operation is the same.

There are many installations today that consist of a fixed head attached to some simple mechanical movement, such as the arm of a vertical drill press. Such installations are generally used in connection with some type of manipulator or weld positioner that can tip the work to any angle and revolve at any suitable speed. Such an installation is particularly suitable for wheel and drum welding, and is also finding extensive application for special types of jobs.

It seems to be impossible to standardize completely on the auxiliary equipment used in connection with standard Unionmelt welding heads because of the many factors that enter the picture. Some of these factors are space available, crane capacity, type of job, type of available equipment for edge preparation, personal inclination of the designing engineers and the possibility of utilizing shop equipment standing idle. Each and every installation has to be judged on its own merits.

From the various types of installations that have been outlined, however, and from the general experience that has already been gained in the use of the process, not only satisfactory installations but also successful applications of Unionmelt welding should be readily derived.

Hardness *vs.* Wear Resistance*

By J. R. Spence†

THE hardness of various alloys has been emphasized to such an extent that the average individual seems to regard this factor as the ultimate in hard-facing metals. It is, of course, true that practically all hard-facing metals are of the hard type alloy, but it is also true that there are many alloys in common use which possess great hardness but which could not be termed hard-facing alloys by any stretch of the term. For example, let us take high-speed steel. This type of alloy, in the heat-treated condition, is considerably harder than the majority of hard-facing metals because extreme hardness is essential for cutting efficiency. High-speed steel, however, was not developed for wear resistance, and consequently does not contain the properties which are necessary for resistance to abrasion.

Generally speaking, the hardness of both heat-treated alloys and of facing alloys is spoken of in terms of Rockwell C and will vary according to the type of material, from Rockwell C 30 to Rockwell C 65.

In the development of alloy steels, which are to be used in their heat-treated condition, the factor of hardness and strength is of prime importance. These steels are, metallurgically speaking, designed to give maximum strength and maximum elongation at a maximum hardness. Steels of this nature are not made for wear-resistant purposes. In the development of hard-facing metals, the factor of most importance is the ability of the alloy to withstand severe abrasion or wear. The applications to which hard-facing alloys are put vary to such a large degree that it becomes imperative to combine properties other than wear resistance in their make-up. Resistance to impact, resistance to heat and resistance to corrosion are properties which are very essential. The fact that a hard-facing alloy is to be subjected to severe impact does not mean that it must be of the softer variety.

A great deal of experimental work has been done relative to the question of hardness and its apparent importance in resistance to abrasion. These tests have been made both experimentally and on practical applications. The results indicate quite conclusively that hard-facing materials which have a hardness of Rockwell C 45 withstand wear and abrasion in ratio from two to one, to as high as ten to one over the best quality heat-treated alloys having Rockwell C hardness as high as 65.

Although it has been found that the wear resistance of alloy steel increases with hardness, this particular

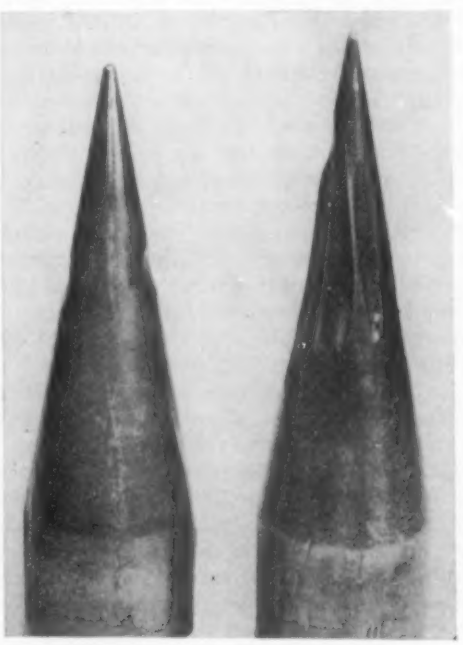


Fig. 1

Needles of this type are used to control the flow of oil from flowing wells. The needle at right was made of tool steel and heat treated to a hardness of approximately 62 Rockwell C. After 24 hrs.' operation it is unfit for further service. The needle at left is made of a hard-facing alloy. It shows less wear at the end of 25 days' operation than the tool steel needle after 1 day's operation. The hardness of Stoodite averages 56 Rockwell C

* Presented at the November 6th Meeting, Oklahoma City Section, A.W.S.
† General Sales Manager, Stoody Company, Whittier, Calif.

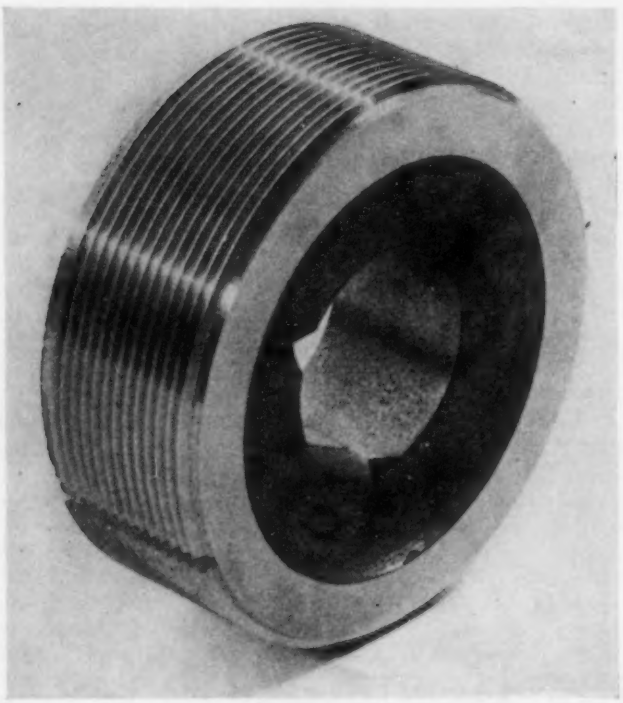


Fig. 2

This thread gage was made of mild steel and hard-faced with Stoodite 45—a metal which has an average hardness of 45 on the Rockwell C scale. It has been in operation 60 days. Superficially hardened thread gages, which average well above 60 on the Rockwell C scale, last just 4 hours.

property does not hold true with hard-facing alloys. While every attempt is made to maintain a constant hardness for various types of hard-facing products, the particular hardness of any one metal is controlled by the type of alloy of which it is composed. In other words, the hardness of any hard-facing material is an indirect property, resulting from the attainment of the desirable amount of wear resistance in combination with other properties essential to the alloy for a particular application. The wear resistance of any alloy depends not only on the amount of alloying element or elements contained in the steel, but also depends on the particular kind of alloy which it contains. Alloy steels of the so-called mild type, with an aggregate of 3 to 6% alloying material as well as high speed and stainless steels containing as much as 25 to 30% alloying materials, have a certain definite amount of wear resistance as compared to mild steel, regardless of whether or not they are in the hardened condition. The wear resistance of these steels will increase by heat treating in approximately the same ratio as a good grade of carbon steel which has been subjected to heat treatment. Heat treatment of high carbon or alloy steels often raises the hardness from 10 to 65 Rockwell C. The increase in wear resistance, due to the increase in hardness, in some cases *may* double the life of the part. Assuming the life of the part to be double when the part has been heat treated to a Rockwell C 65, it is possible by the use of a hard-facing material to increase the life of this heat-treated part several times.

Hardness in connection with hard-facing metals should be of secondary importance. The real purpose of hard facing is to retard wear. Consequently, in the selection of the proper type of hard-facing metal, the question is: "Which one will wear longest?"—not "Which one is the hardest?" Taking into consideration other factors such as heat, impact, corrosion, etc., the question of which one will wear the greater length of time is naturally much more important than the hardness of the hard-facing alloy used. If the hardness were the deciding factor in facing metals, then it would only be necessary to obtain a steel which could be heat treated. It would then be possible not only to secure the same hardness as obtained by hard facing, but to secure a hardness in excess of hard-facing materials. Such practice would, however, give only additional hardness and not to any extent additional wear or abrasion resistance.

Grinding

One of the most common ideas regarding hardness (which is entirely erroneous) is the question of hardness in relation to the apparent ease or difficulty with which any particular alloy can be ground. In considering a grinding job on any piece of heat-treated or ordinary steel, there are never any anticipated difficulties in which hardness could be considered as taking part. In other words, it is comparatively easy to grind any type of heat-treated steel regardless of its Rockwell C hardness. In the case of hard-facing materials, however, other elements are to be considered. For instance it is quite common to have serious complaints with the inability of the machinist to grind the material without using a great deal of time and losing considerable wheel. In this connection, it should be remembered that hard-facing alloys have been developed to resist the action of grinding wheels (which is one type of abrasion) to the maxi-

Fig. 3

This worn rocker arm, from a large motor bus engine, was rebuilt by the application of a very thin layer of hard-facing alloy, which has an average hardness of 56 on the Rockwell C scale. Several of these hard-faced rocker arms have now been in continuous operation more than 1 year and from all appearance will last another 2 or 3 years before reconditioning is again necessary. Heat-treated rocker arms, which have an average hardness of 60 Rockwell C usually last a maximum of 6 months.

mum extent. Consequently, it is to be desired that the hard-facing material be as difficult to grind as possible in order that the facing resist the wearing action for which purpose it was intended. It is significant that the difficulty of grinding has little or no connection with the hardness of an alloy, particularly when that grinding is to form the base of a comparison between heat-treated steel and a facing material. Of course, all hard-facing materials are comparatively hard to grind, but a heat-treated alloy of the same hardness or considerably greater hardness, can be ground with comparative ease. As an example, we could take a shaft which has been hard faced with a coated hard-facing rod with a Rockwell hardness of C 56. It will be found that the average machinist in grinding this shaft will complain, not particularly because it is so difficult to grind, but rather because it is too hard to grind. This is entirely erroneous. Actually the hard-facing alloy is not as hard as heat-treated high-speed steel, but since it was developed for the purpose of resisting the action of a grinding wheel or any other type of abrasion, it is to be expected that this alloy will be difficult to grind. Inasmuch as the high-speed steel was not developed to resist the action of grinding, it is natural to suppose that it can be ground with comparative ease. Regardless of the relative hardness of these two materials or the relative hardness of any hard-facing metal and any heat-treated or high-carbon alloy steel, it can be definitely stated that the hardness can not be estimated with any degree of accuracy by the relative ease or difficulty with which these two types of material can be ground. It is possible to get a rough estimate as to the wearing properties of various hard-facing materials by a comparative grinding test which, however, will not indicate the actual or approximate hardness in comparison with the hardness of various alloys and heat-treated steels. All hard-facing materials have been designed to resist the action of grinding to a maximum degree comparable with other properties incorporated in the alloy which may be desirable for its intended use.

Carbides

It should be understood that hard-facing materials which are composed of tungsten carbide contained in steel tubes cannot be considered as homogeneous alloys. In, the application of these welding rods the deposit is composed of particles of tungsten carbide contained in a matrix of relatively soft metal. The abrasion resistance of these deposits depends entirely on the amount and distribution of the tungsten carbide particles. Tungsten carbide, as we know, is usually compared with the diamond relative to its hardness. This is undoubtedly due to the fact that this carbide has a hardness which approaches that of the diamond. However, it appears that the actual hardness of this material is used as a basis from which its great wear and abrasion resistance can be estimated. There can be no question as to the fact that tungsten carbide for hard-facing uses is indeed the ultimate in wear resistance. However, it is entirely within reason to think that the wear resistance of tungsten carbide is a function of its properties. In other words, the hardness of tungsten carbide is a contribution but could not be considered as the sole reason of the outstanding resistance to abrasion which this material possesses.

A very good example of the relationship of hardness to abrasion resistance is to be found in the application of the so-called tough type of tungsten carbide as compared with the regular or 100% tunsten carbide alloy.

Fig. 4

These valve tappets are made of a heat-treated alloy steel and are used in small racing motors. When unprotected, tappets of this type must be ground after every race. After an application of hard-facing alloy, which has a hardness of 45 on the Rockwell C scale, these tappets lasted 18 months during which time they were ground just twice.

The toughness of the tough carbide is imparted by the addition of small amounts of alloy, usually cobalt. The addition of this metal to the carbide has a pronounced effect upon the hardness of the product, making this type of alloy softer than regular tungsten carbide. While this alloy is softer and has a tendency to round off in practice, the actual wear resistance of this material is comparable with that of the harder type of carbide. This, however, applies only to the application of this material as a wear-retarding medium. By far the greatest use of these alloys are for earth-cutting implements, particularly relating to the oil well drilling industry. For this type of work it is necessary to have the harder type of alloy available in order that the greatest cutting efficiency be maintained through the application of an extremely hard and relatively brittle metal. For this reason it is desirable to apply this material in such a manner that the use of the implement will afford an opportunity for the carbide to break off; thus exposing new and sharp edges and points for the cutting action of the implement or bit. The use of the tough type carbide defeats the very purpose for which a carbide faced bit or implement has become famous. That is, in the action of the cutters on the earth, it is only logical to suppose that the more a sharp surface is exposed to the work the more hole that sharp surface cuts. In the use of the tough type of material, this material does not break off readily nor does it continuously expose new sharp surfaces. Instead it wears away to a rounded, blunt end and relies entirely on its ability to resist wear for its cutting action. We have here a situation very similar in nature to the one of hardness in relation to hard-facing alloys. When we want an alloy that will retard wear to a maximum degree we get that particular alloy regardless of its hardness. The same thing applies to earth-cutting tools. When we want a facing that will cut we get the alloy that will do the most cutting in the least time with the least effort and power.

So far as the question of hardness *vs.* wear resistance is concerned, this subject deals with hard-facing materials which are the homogeneous type only. In the choice of the correct hard-facing materials to use for any application it becomes necessary to consider all the various factors which have a bearing on the problem, such as impact, heat, corrosion, etc., and to select the hard-facing rod that will have the desirable properties in sufficient amount to meet these secondary conditions and be assured that the hard-facing material will deliver the maximum resistance to wear consistent with the various other properties desirable. It may be definitely stated that with the choice of the proper facing material for any application, the question of hardness of the facing alloy may be entirely ignored.

American Standard Code for Pressure Piping*

Power, Gas and Air, Oil, District Heating, Refrigeration, Fabrication Details, Materials

Editorial Note: Chapters 4 and 5 of Section 6, prepared largely by a Committee of the AMERICAN WELDING SOCIETY, *are reproduced herewith. Appendices in the Code also include Procedure and Operators Qualification Codes based on corresponding codes of the A. W. S. Price of complete code, 227 pages, $2.00.*

Chapter 4. Welding of Pipe Joints[1]

621 General. (a) This chapter concerns the fusion welding of pipe joints by the electric arc and gas welding processes, and relates to such joints as are formed by (1) pipe end to end, (2) pipe branches, (3) pipe to flanges, fittings, and valves; and (4) pipe, valve, or fitting, etc., to welding connections provided on apparatus or equipment, except where the welding of such joints is covered by other code requirements (such as the Power Boiler and Unfired Pressure Vessel sections of the A.S.M.E. Boiler Construction Code). It is not intended to deal with the design of special fabricated pipe fittings and valves, but it does pertain to the fusion welds made in the fabrication and joining of such fittings. The general provisions of this chapter are subject to accompanying code regulations as to pressure, temperature, and fluid carried.

(b) These rules are intended to apply primarily to the manual application of the arc and gas welding processes, and to the materials permitted under the various sections of this code, which in their unwelded condition meet the requirements of the guided bend test.[2]

Each manufacturer or contractor shall be responsible for the quality of the welding done by his organization and shall conduct tests not only of the welding procedure to determine its suitability to ensure welds which will meet the required tests, but also of the welding operators to determine their ability to make sound welds under standardized test conditions.

It is assumed that the manufacturer or contractor performing the welding has an organization familiar with this code and capable of designing, engineering, and supervising welded piping construction.

Rules for the qualification of a welding procedure are given in Appendix I, Part I. Rules for the qualification of operators are given in Appendix I, Part II.

622 Definitions. For convenience in reference, some of the more common terms relating to pipe welding are defined herein. These definitions are in substantial agreement with the AMERICAN SOCIETY pamphlet, "Definitions of Welding Terms and Master Chart of Welding Processes," January 1940. For definitions of terms not contained herein, reference shall be made to the A.W.S. pamphlet.

(a) ARC WELDING. A fusion welding process wherein the welding heat is obtained from an arc either between the base metal and an electrode, or between two electrodes.

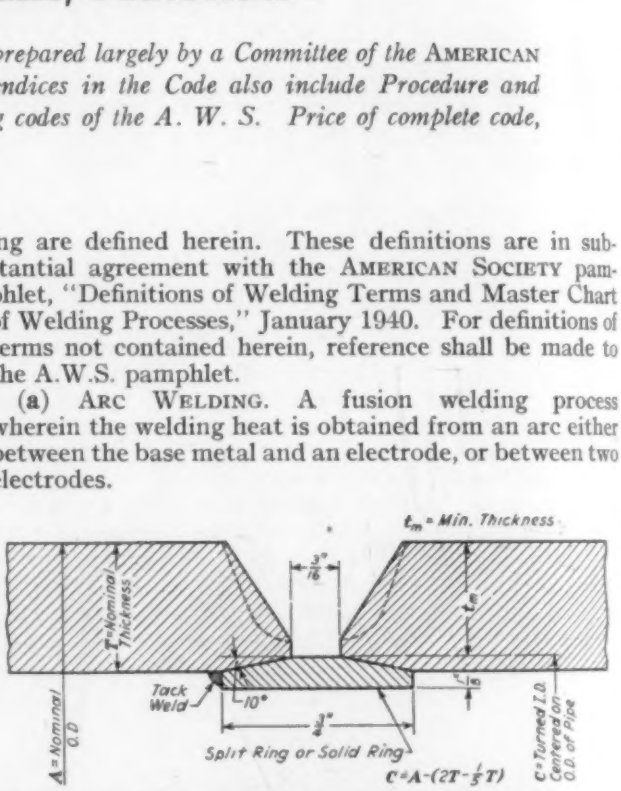


FIG. 7 V-BUTT JOINT WITH INTERNAL BEVEL AND RING TO FIT

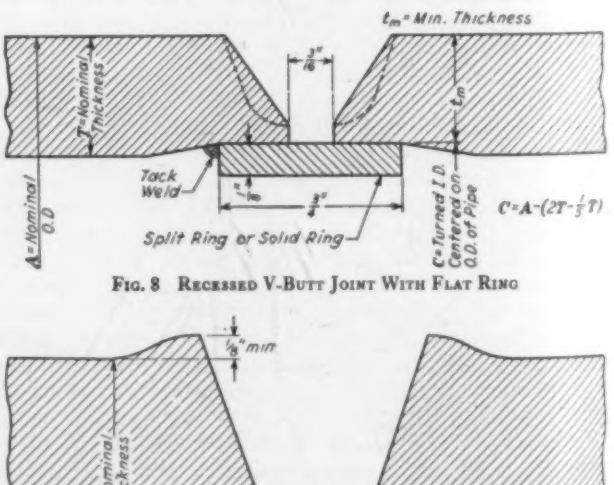


FIG. 8 RECESSED V-BUTT JOINT WITH FLAT RING

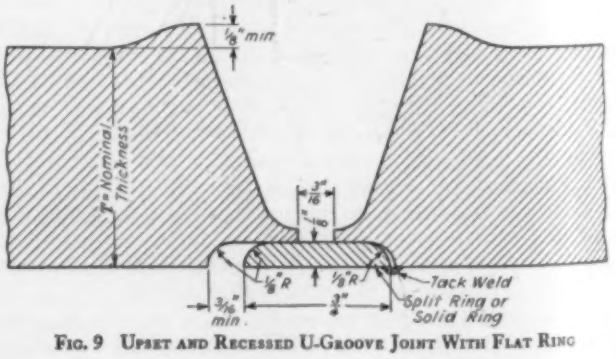


FIG. 9 UPSET AND RECESSED U-GROOVE JOINT WITH FLAT RING

* Approved by American Standards Association, November, 1942. Sponsor Body, The American Society of Mechanical Engineers, 29 W. 39th St., New York, N. Y.

[1] The AMERICAN WELDING SOCIETY through its Pipe Welding Code Committee cooperated with the Sectional Committee on a Code for Pressure Piping in the preparation of this chapter on Welded Pipe Joints.

[2] It should be understood that there are materials not covered in the above statement that are weldable, some of which may meet the welding requirements of the code. These and materials, which in the unwelded condition will not meet the guided bend test, may be welded provided special welding processes and test requirements are set up in specifications.

(b) BACKING RINGS. Material (metal, asbestos, carbon, etc.) backing up the root of the weld to facilitate complete penetration and to prevent weld spatter reaching the interior of the pipe. (See Fig. 7.)

(c) CONCURRENT HEATING. Supplementary heat applied to a structure during the course of welding (see Preheat).

(d) DEPOSITED METAL. Metal that has been added by a welding process.

(e) ELECTRODE. (Metal Arc Welding) Filler metal in the form of a wire or rod, either bare or covered, through which current is conducted between the electrode holder and the arc.

(f) FILLER METAL. Material to be added in making a weld.

(g) FILLET WELD. (1) The form of a fillet weld is shown in Figs. 16 and 21.

(2) The size of a fillet weld is the leg length of the largest inscribed isosceles right triangle.

(h) FUSION WELDING. A group of processes in which metals are welded together by bringing them to the molten state at the surfaces to be joined, with or without the addition of filler metal, without the application of mechanical pressure or blows.

(i) GAS (FLAME) CUTTING. The process of severing ferrous metals by means of the chemical action of oxygen on elements in the base metal.

(j) GAS WELDING. A fusion welding process wherein the welding heat is obtained from a gas flame.

(k) GROOVE BUTT WELD. (1) The bevel form of a single V-groove butt weld is shown in Fig. 12, and the bevel form of a single U-groove butt weld is shown in Fig. 11.

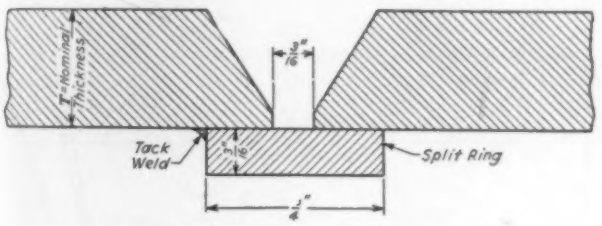


FIG. 10 V-BUTT JOINT WITH FLAT RING

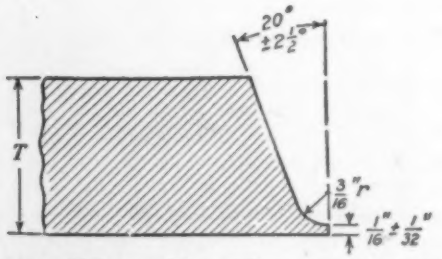


FIG. 11 STANDARD U-BEVEL OF WELDING ENDS FOR THICKNESS (T) GREATER THAN 3/4 IN.
(This form of bevel is not recommended for acetylene welding and may be changed to straight bevel as in Fig. 12.)

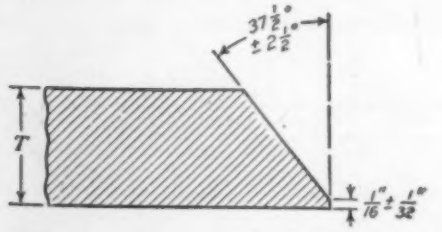


FIG. 12 STANDARD STRAIGHT BEVEL OF WELDING ENDS FOR THICKNESS (T) 5/16 TO 3/4 IN. INCL.
(For electric arc or acetylene welding.)

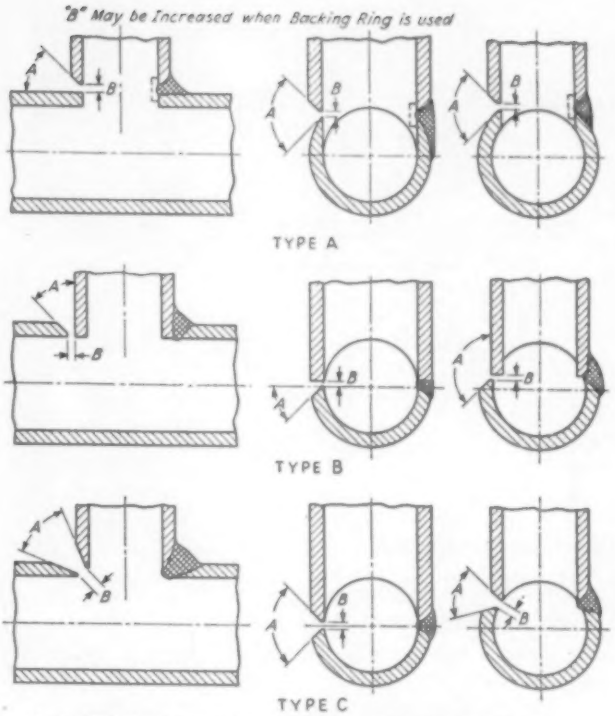

"B" May be Increased when Backing Ring is used
TYPE A
TYPE B
TYPE C
Angle "A" to be Not Less than 45° for any Wall Thickness of Pipe
"B" to be Not Less than 1/16" nor More than 1/4"

FIG. 13 ACCEPTABLE TYPES OF PREPARATION FOR 90 DEG FULL SIZE AND 90 DEG REDUCED SIZE BRANCH CONNECTIONS

(2) The size of a groove weld is the depth of the groove. Where fusion materially exceeds the groove depth, the size of the weld is the depth of the groove plus the depth of fusion.

(l) GUIDED BEND TEST. A bending test wherein the specimen is bent to a definite shape by means of a jig. (See Fig. 30.)

(m) PENETRATION. The depth of fusion, or penetration, of a weld is the distance from the original surface of the metal to that point at which fusion ceases.

(n) PREHEAT. Heat applied prior to welding or cutting operations. (See Concurrent Heating.)

(o) QUALIFICATION TESTS. (1) Procedure. A series of tests to determine that joints made by the particular methods and practices involved in the production of a welded joint by an organization will produce a satisfactory weld. Rules for qualification of a welding procedure are given in Appendix I, Part I.

(2) Operators. A series of tests to determine the operator's ability to make sound welds under certain specified standardized conditions. Rules for the qualification of operators are given in Appendix I, Part II.

(p) REINFORCEMENT. Reinforcement of a weld is deposited metal added at the throat beyond the minimum thickness. (See Pars. 622g(2) and k(2).)

(q) RESIDUAL STRESS. Stress remaining in a structure or member as a result of thermal or mechanical treatment, or both.

(r) ROOT OF WELD. The root of the weld is the zone at the bottom of the cross-sectional space provided to contain a fusion weld.

(s) SEAL WELD. A weld used primarily to insure tightness on the supposition that mechanical strength of the joint is otherwise obtained.

(t) STRENGTH WELD. A weld designed to have a predetermined strength and primarily intended to provide a mechanically strong joint.

(u) STRESS RELIEF HEAT TREATMENT. Uniform heating of a structure or portion thereof to a sufficient

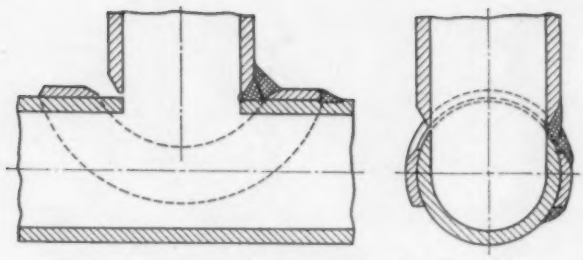


FIG. 14 STRAP REINFORCEMENT WITH TYPE "A" PREPARATION

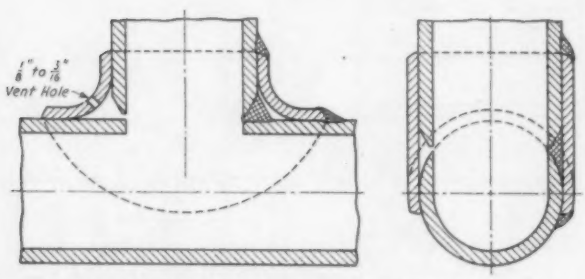


FIG. 15 SADDLE REINFORCEMENT WITH TYPE "A" PREPARATION

FIG. 16 MINIMUM REQUIREMENTS FOR SOCKET AND FILLET WELD DIMENSIONS

temperature below the critical range, to relieve the major portion of the residual stresses, followed by uniform cooling. (The terms normalizing, annealing, etc., are misnomers for this treatment.)

(v) TACK WELD. A weld used for assembly preparation purposes only.

(w) THROAT. The throat is the minimum thickness of a weld, not including reinforcing, along a straight line passing through the root.

(x) WELD. A localized consolidation of metals by a welding process.

(y) WELDING OPERATOR. An operator of welding equipment.

(z) WELDING PROCEDURE. The detailed methods and practices involved in the production of a welded structure.

623 Materials. (a) The materials for pipe, fittings, valves, and flanges shall conform to the requirements of the various sections of this code.

(b) Material to be welded shall be of weldable quality, free from harmful laminations, ingredients, or defects.

624 Fusion Welded Joints. (a) BUTT WELDS. (1) Butt welds may be of either the single "V," double "V," "U" bevel, or other suitable type. The edges of the parts to be joined shall be beveled and spaced where necessary and the welding procedure shall be such as to insure a depth of the deposited metal adequate for the service involved and thorough fusion of the deposited metal with the base metal. In the case of a single "V" or single "U" bevel (without the use of a backing ring), where it is difficult to obtain complete penetration to the bottom of the joint or inside surface some allowance should be made for lack of penetration of fusion down the inside of the joint, due to variations in pipe wall thicknesses, eccentricity, slight misalignment, etc. In no case shall the lack of penetration be sufficient to reduce the net throat thickness of the weld below the minimum wall thickness requirement for the various classes of service, based upon the design formulas including any factor "C" allowance for mechanical strength, and/or corrosion given in the various sections of the code. If the pipe wall is recessed for a backing ring, the depth of such recess shall be so limited that the remaining net section of the finished joint is not less than the minimum required thickness.

(2) The throat of a butt weld shall be at least equal to the thickness of the thinner part joined.

(3) Butt welds shall be reinforced in excess of the net throat at least 1/16 in. Removal of reinforcement shall be permissible, but if the reinforcement is not removed, it should be so built up that there is a gradual increase in thickness from edge to center.[1]

(b) BACKING RINGS. (1) Reference is made in Par. 624(a) to the use of backing rings. The proportions of backing rings shown in Figs. 7, 8, 9, and 10, and the provisions in subparagraphs (2), (3), and (4) are given as representing "recommended practice" where backing rings are required or used. It is recommended

[1] Excessive reinforcement is not desirable, as it may introduce undesirable stress concentrations.

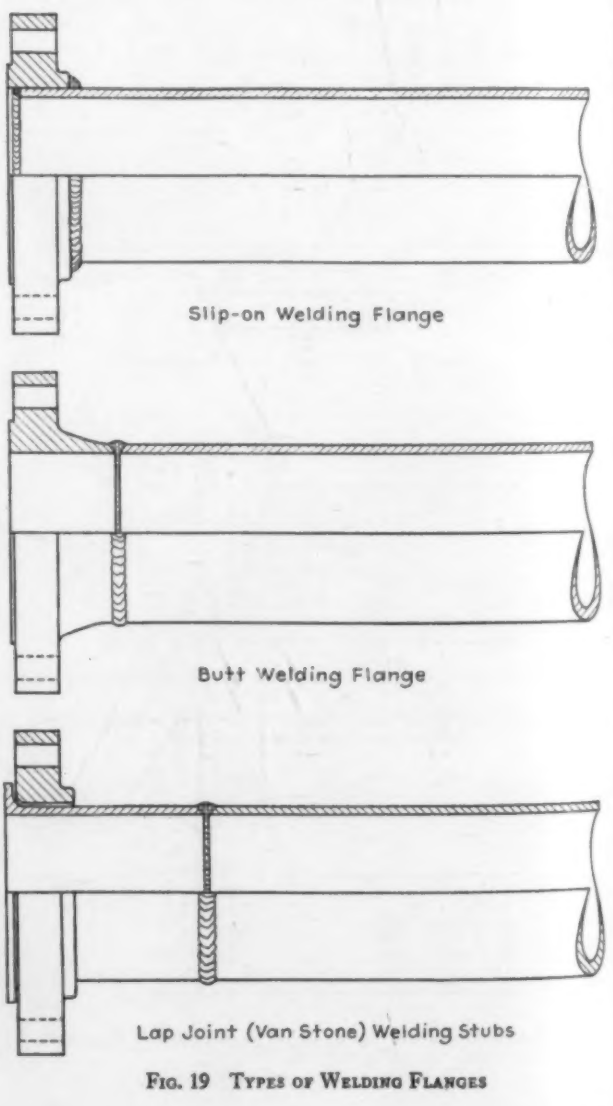


FIG. 19 TYPES OF WELDING FLANGES

that welding ends be prepared as shown in Figs. 11 and 12. (These figures are identical with those shown in American Standard ASA B16e.)

(2) Where the nominal pipe wall thickness is 1/2 in. or less, or where it is not considered necessary or practical to machine the inside of the pipe, the recommended practice is as shown in Fig. 10.

(3) Where the nominal pipe wall thickness is over 1/2 in. but is 3/4 in. or less, and where it is considered necessary to machine the inside of the pipe, the recommended practice is as shown in Figs. 7 and 8.

(4) Where the nominal pipe wall thickness is over 3/4 in., the recommended practice is as shown in Figs. 7, 8, and 9.

(c) FILLET WELDS. (1) Fittings other than flanges may be attached by fillet welds, provided the pipe is inserted in the fitting and provided the fillet welds meet the requirements of Figs. 16 and 20. (2) Fillet welds for the attachment of flanges shall be as shown in Fig. 20. (3) The throat dimension of fillet welds shall not be less than the nominal pipe wall thickness.

(d) SEAL WELDS. (1) Seal welds shall not be considered as contributing to the strength of joints.

(2) When applied to riveted and similar joints, the tightness of the riveting or other fastening shall be checked before and after seal welding. Seal welding shall not be applied to tighten loose rivets or other fastening.

(e) Welds shall not have depressions at the edges exceeding 1/32 in. in depth below the surfaces of the parts joined.

625 Welding Flanges and Fittings. (a) Flanges, fittings, valves, or other piping equipment may be provided with welding ends suitable for welding directly into a pipe line, but their design must be such that no damage will result from the welding or stress-relieving operation so as to render the equipment useless or unsafe for service.

(b) Welds for steel flange connections shall be of suitable design, providing complete fusion of the deposited metal with the base metal. The component parts of the joint shall meet the pressure and service requirements of the system. (See Fig. 19.)

626 Welding Procedure.[1, 2] (a) Beveling shall preferably be by machine, but may be done by flame cutting if the surfaces are later thoroughly cleaned from scale and oxidation.

(b) Surfaces for welding shall be cleaned and shall be free from paint, oil, rust, or scale before welding, except that a light coat of a rust preventing preservative which will not be detrimental to the finished weld, may be used.

(c) Before welding, the piping or other equipment shall be carefully lined up so that no part is offset with respect to the adjacent part by more than 20 per cent of the pipe thickness. This alignment must be preserved during welding.

(d) If tack welds are used, they shall be of the same quality and made by the same procedure as the completed weld. Otherwise they shall be removed during the welding operation.

[1] When welding a connection, bracket, or part, or making repairs by welding on any valve, controlling fixture, sliding expansion joint, or other equipment, the welding heat might cause distortion of the valve seat, slide guide, or other operating part, according to the proximity of such part to the weld. It is therefore imperative, when performing such work, to ascertain whether the equipment should be removed from the line or be dismantled or whether proper protection can otherwise be provided to prevent damage to the working parts. After the work has been completed, a test shall be made to prove that the working parts are functioning properly before putting the equipment into service.

[2] When repairing defects in forged or cast-steel flanged valves or fittings, or seal welding joints in flanges in place, it is recommended that the flange bolts be loosened enough to prevent expansion strains from affecting the welds or bolts. Where desired, temporary erection bolts may be used during erection.

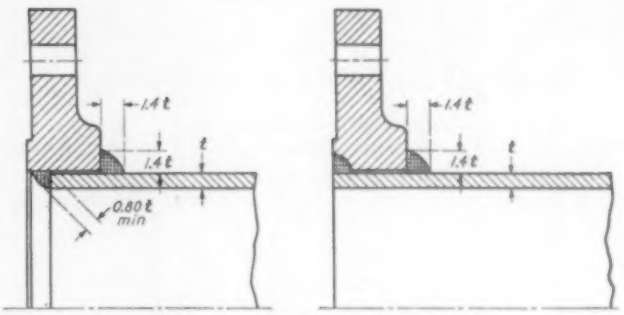


FIG. 20 DETAILS OF SLIP-ON WELDING FLANGES

(e) No weld metal shall project within the pipe so as to seriously restrict its area or cause danger of loosening and falling into the pipe.

627 Preheating. Welded joints in carbon steel having a carbon content in excess of 0.35 per cent with a nominal pipe wall thickness of 1/2 in. or greater, and in carbon-molybdenum steel, shall be preheated adjacent to the welding zone to a temperature of not less than 400 F. This preheating may be accomplished by any suitable method, providing that it is uniform and that the temperature is maintained during the actual welding operation.

628 Stress Relieving. (a) (1) Welded joints in carbon steel shall be stress relieved by one of the methods described in this section when the nominal pipe wall thickness is 3/4 in. or greater.

(2) Welded joints in carbon steel having a carbon content in excess of 0.35 per cent, and in carbon molybdenum steel, shall be stress relieved when the nominal wall thickness is 1/2 in. or greater.

(3) In all cases, the member having the highest carbon content or the greatest wall thickness adjacent to the point of welding, shall govern. When slip-on type flanges are attached by fillet welds, the thickness of the pipe shall govern.

(b) Stress relieving shall be done by heating to a temperature between 1100 F and 1250 F. The parts heated shall be brought slowly to the required temperature and held at that temperature for a period of time proportioned on the basis of at least one hour per inch of pipe wall thickness for carbon steel and two hours per inch of pipe wall thickness for carbon-molybdenum steel, but in no case less than 1/2 hour, and shall be allowed to cool uniformly.

(c) Stress relieving shall be accomplished by one of the following methods:

1. Heating the complete structure as a unit.
2. Heating a complete section containing the weld or welds to be stress relieved before attachment to other sections of work.

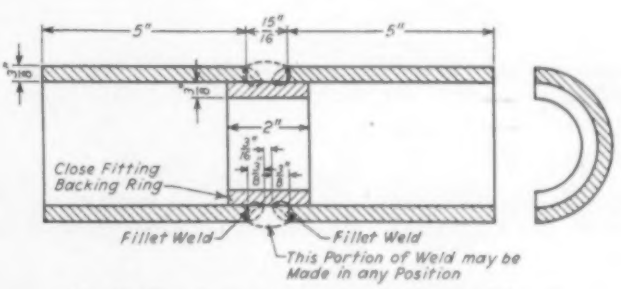


FIG. 21 TEST JOINTS FOR FILLET WELD SOUNDNESS TEST

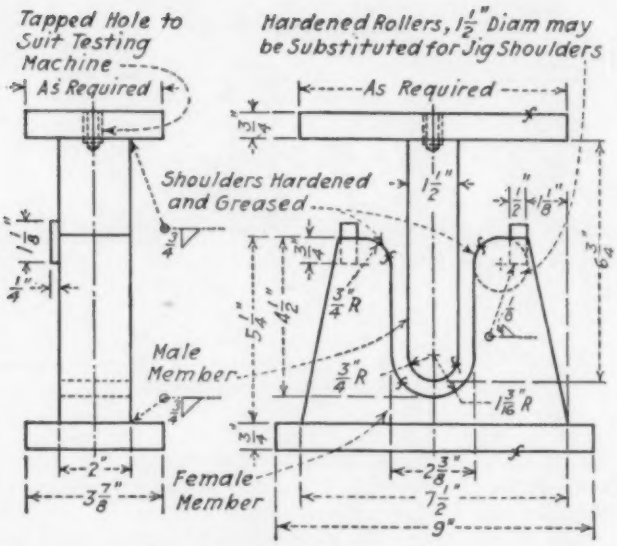


FIG. 30 GUIDED-BEND TEST JIG

3. Heating a part of the work by heating slowly a circumferential band containing the weld at the center. The width of the band which is heated to 1100 F-1250 F shall be at least equal to twice the width of the weld,[1] and the temperature shall be allowed to diminish gradually outward from the ends of this band.

629 Identification. After completing a welded joint, the welding operators shall stamp it with numbers or marks to identify it as their work. The weld shall be stamped with the last two numbers of the year in which it was made.

630 Hydrostatic Tests. (a) Piping and associated equipment fabricated with welded joints shall be capable of withstanding hydrostatic tests as specified in the section of this code covering the class of service for which the pipe is to be used.

(b) In all cases, the required test pressure shall be maintained a sufficient length of time to enable an inspection to be made of all joints and connections.

(c) By agreement between the purchaser and the contractor, welded joints may be given a hammer or impact test where such a test is feasible. This hammer or impact test shall consist of striking the pipe at 6-in. intervals on both sides of the welded joint. The weight of the hammer in pounds shall be approximately equal to the thickness of the pipe wall in tenths of an inch, but shall not exceed 10 lb. The edges of the hammer shall be rounded so as to prevent defacing the pipe.

631 Acceptance and Rejection. (a) By agreement between the purchaser and the manufacturer or contractor, the quality of the work may be checked by the removal of a section of pipe containing the weld and large enough to permit proper inspection. Failure of such a weld to meet the requirements of Part 2 of Appendix I, shall be cause for the removal of a second weld made by the same welding operator. Failure of the second weld shall be cause for the suspension of the welding operator until he can show proof that his work fully meets the requirements for uniformly satisfactory welds.

(b) (1) Any defects to be repaired shall first be removed by chipping, machining, or flame cutting the entire defect prior to rewelding. The removal of the defect shall be such that the repaired weld will meet the requirements of the code.

(2) For repairs by gas welding, the metal around the groove shall be preheated to a dull red.

(3) Repairs in carbon steel or carbon molybdenum steel material welded by the metallic arc process shall be preheated and/or stress relieved only if required for original weld. If no preheating is to be employed, care shall be exercised to prevent an excessive accumulation of heat localized in the area of the repair.

(4) In all repair work, the same welding technique shall be employed, as in the original weld.

(c) Seal welds showing defects may be rewelded. Where the defect is of considerable extent, the defective weld metal shall be chipped out so that the required cross-section of the finished weld will be maintained.

(d) General sweating of any weld is cause for its rejection, complete removal, and rewelding.

632 Qualification of Procedures and Operators. The qualification of welding procedures and operators for welded joints in pipe shall be in accordance with Parts 1 and 2 of Appendix I.

Chapter 5. Welded Branch Connections and Fabricated or Cast Specials

633 This chapter concerns the methods to be followed in the fabrication of intersecting welded branch connections and is limited principally to those branch connections in which the angle between the outlet and the run is not less than 85 deg. It also deals with fabricated specials as covered in Par. 635. All the provisions of Chapter 4, so far as they apply, shall be followed.

634 Welded Branch Connections. (a) Some acceptable types of preparation for welded branch connections which have been found to be satisfactory by tests, are shown in Fig. 13.

(b) The contours of the openings in the run and the end of the outlet shall be such as to make an accurate fit-up.

The edges of the pipe at the roots of the joints shall be not closer than $^1/_{16}$ in. nor more than $^1/_4$ in. except when backing rings are used.

(c) A header having a branch or branches attached by welding shall be reinforced to make it at least equivalent in strength to the bursting strength of a straight section of pipe as determined by the formulas for pipe wall thickness given in Sections 1 to 5, inclusive, of this code.

The necessity for and the amount of reinforcement required in the crotch section shall be determined by the rule that the area available for reinforcement shall be equal to or greater than the required area as defined as follows: The required area shall be determined as the cross-sectional area of the finished opening in the header, considered as a rectangle whose length is the diameter of the finished opening and whose height is the theoretical minimum wall thickness of the header. The hole to be compensated for by reinforcement shall be measured on the diameter of the outlet parallel to the axis of the run. The available area included as reinforcement shall be at least the sum of the following cross-sectional areas:

1. The cross-sectional area of the fillet welds adjacent to the nozzle and above the outside surface of the header.
2. The cross-sectional area of the branch determined from the minimum thickness on inspection and a height equal to $2^1/_2$ times the minimum thickness of the branch wall above the outside surface

[1] Width of weld is the width of the widest part of the welding groove. In no case shall the width of the band be less than the width of the weld reinforcement.

of the header, or above the outside of the reinforcing ring or saddle, if used.

3. Any additional thickness of the wall of the header above the theoretical minimum thickness required by the wall thickness formulas of Sections 1 to 5, incl., for a distance equal to the inside diameter of the branch on each side of the center line of the branch.

In case the sum of these available areas is less than the required area, additional reinforcement shall be provided. This additional reinforcement shall be obtained by additional thickness of header wall and/or branch wall, ring, saddle and/or weld metal. (See Figs. 14 and 15.)

The material used for ring or saddle reinforcement may be of specifications differing from those of the pipe, provided the cross-sectional area is made in proportion to the relative strength of the reinforcement and pipe materials at the operating temperature and provided it has welding qualities comparable to those of the pipe. No credit shall be taken for the additional strength of material having a higher strength than that of the part to be reinforced.

When rings or saddles are used which cover the weld between branch and header, a vent hole shall be provided in the ring or saddle to reveal leakage in the weld between branch and header and to provide venting during welding and heat treating operations.

The use of ribs or gussets shall not be considered as contributing to reinforcement of the branch connection. This does not prohibit the use of ribs or gussets for purposes other than reinforcement.

Fillet welds used in attaching the reinforcement shall be full fillet welds.

Reinforcing rings and saddles shall be accurately fitted to the parts to which they are attached. Figures 14 and 15 illustrate some acceptable forms of reinforcement.

(**d**) Branch connections attached at an angle less than 85 deg. to the run become progressively weaker as the inclination becomes less. Any such designs must be given individual study and sufficient reinforcement must be provided to compensate for the inherent weakness of such construction. The use of encircling ribs to support the flat or reentering surfaces is permissible, and may be included in the strength calculations.

635 Fabricated or Cast Specials. (**a**) Fabricated swages, orange-peel bull plugs, segmental elbows, and other special fittings may be formed from pipe or plate material and welded in accordance with the general requirements for welded joints specified in this section. Design shall be such that all special fittings will be equivalent in strength to the computed bursting strength of a straight section of pipe as determined for the service conditions by the formulas for pipe wall thickness given in Sections 1 to 5, inclusive, in this code. The inherent weakness of such designs shall be taken into account in establishing the service conditions under which they may be used.

(**b**) Cast special fittings with welding ends shall conform to material requirements of A.S.T.M. Specifications A216 or A217, and shall be designed in accordance with requirements of American Standard B16e, or Par. 634 if practicable. Where rules of American Standard B16e are applied in the design of such fittings, the shape factor employed in determining minimum wall thickness may be omitted for the cylindrical or tapered ends. When welding ends of castings are finish machined both inside and outside and carefully inspected, the quality factor at the welding ends may be taken as 100 per cent, but in no case shall the thickness of the welding end be less than the wall thickness of the mating pipe.

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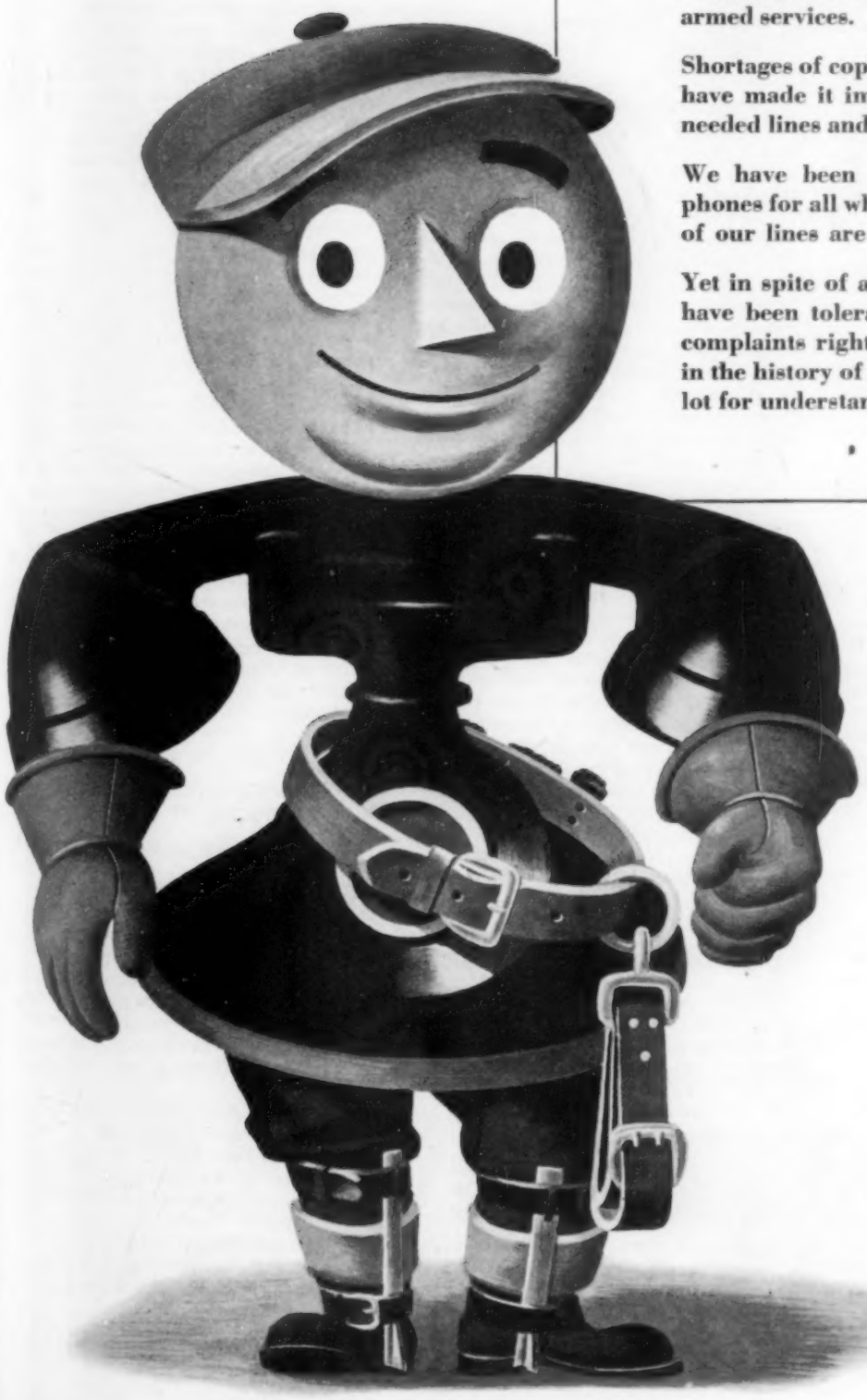


BELL TELEPHONE SYSTEM

WAR CALLS COME FIRST

THE AMERICAN WELDING SOCIETY

ACTIVITIES — RELATED EVENTS

PRESIDENT HANSEN'S SON KILLED

It is with great regret that we are obliged to announce the death of Lt. James S. Hansen of Milwaukee, who died in a plane crash on January 2nd. He was killed when the Army bomber he was piloting crashed in Columbus, Ohio. An account in a Milwaukee newspaper states that Lt. Hansen could have easily bailed out of his plane and saved his own life, but instead he tried desperately to get out of the congested area before his plane finally come down, thus giving his own life to save hundreds of others.

Lt. Hansen was 33 and was a pilot for the Army ferry command. Military funeral was held and an honorary escort from Ft. Sheridan participated at the services.

SECTION ACTIVITIES WORTHY OF SPECIAL MENTION

In the January issue of THE WELDING JOURNAL we reported on membership gains during the months of October and November, giving special recognition to the Sections which, more or less, doubled the gain attained by the Society. Our report should have included the month of September, as the Annual Report published in the Year Book showed the percentage gain for the year ending August 31, 1942. This omission was unfortunate in that one of the Sections had a considerable membership increase in September. Our attention has been drawn to this fact by the Los Angeles Section, which incidentally had a gain in membership over the year of approximately 60%. There may be others that have accomplished a similar feat and have not received due credit. It is hoped these Sections will write us.

It is proper, also, at this time, that our gratitude be expressed to the Detroit and Northern New Jersey Sections for the exceptionally fine work they are doing in enrolling Sustaining Members. A more complete report will be included in a future issue of THE WELDING JOURNAL.

M. M. KELLY, *Secretary*, A. W. S.

HANDY & HARMAN GETS PRODUCTION AWARD STAR

G. H. Niemeyer, president of Handy & Harman, announced on February 10th that his company has been granted a renewal of the Army-Navy "E" Award. This gives the company the right to add a white star to the pennant originally awarded last August.

COMMUNICATION TO THE EDITOR

Office of

ALIEN PROPERTY CUSTODIAN

Washington

January 18, 1943

Dear Sir:

The United States Government, through the Office of Alien Property Custodian, now holds about 50,000 patents formerly owned by residents of enemy and enemy-occupied countries. The inventions disclosed in these patents represent research achievements of great potential value.

It is our privilege to offer these patents for use by American industry. They will have high usefulness as a means toward winning the war and as a contribution toward rebuilding our peacetime economy. The success of this program will depend largely on how rapidly and effectively American business utilizes the inventions covered by these patents for increased and improved production.

A pamphlet has been prepared to provide American industry with a brief outline of the policies which have been adopted for the administration of these patent holdings. There is also included an index to the classified lists of vested patents for use as a guide in ordering specific sections.

Copies of this pamphlet are being sent to businessmen, research workers and many others interested in the use of patents, but your influence as an editor can be of tremendous help in carrying out this program. Your cooperation is earnestly solicited in bringing it to the attention of your readers.

Very truly yours,
LEO T. CROWLEY,
Alien Property Custodian

ANOTHER ARMY-NAVY "E" AWARD

We are proud to announce that the Army-Navy "E" Award was presented to the employees and management of the Kansas City Structural Steel Co. for excellence in war production. Ceremonies took place on Friday, January 22, 1943.

OFFICE OF WAR INFORMATION WAR MANPOWER COMMISSION

Holders of war contracts who need workers with certain important skills are requested to make these requirements known at once to all local offices of the United States Employment Service, the War Manpower Commission announced. The twenty-five special skills for which an intensive recruitment drive is being undertaken are:

Airplane skin man; airplane subassembler, ammunition inspector, ship assembler, metal work bench hand, bus driver, ship carpenter, cord wood cutter, crane rigger, cylindrical grinder operator, ship driller, electrician (ship), flanging press operator, internal precision grinder, machinist, metal operator, internal precision grinder, outside machinist, metal chipper, milling machine operator and milling machine operator (all-round), explosives mixer operator, radio chassis assembler, rough or finish ship painter, plate hanger, automatic or semi-automatic screw machine operator, tack welder and licensed marine engineer.

A nation-wide search for men and women who have ever been employed in these occupations or who are now engaged in such work in non-war industry is now proceeding. Appeals to persons so qualified to register at their nearest United States Employment Service office are being made by radio, by special posters, and through the press and various national magazines.

Available openings for such workers, if listed immediately, will enable the United States Employment Service to refer such workers as may be discovered to specific jobs without delay. This procedure will assure the placement of needed men in important war industries, the Commission points out.

ELECTRONIC CONTROL SPECIALIST NAMED

John J. Fiske, has been named electronic control specialist for the Westinghouse Electric & Mfg. Co. in the Los Angeles area. Announcement of the appointment was made recently by A. J. Bronold, Los Angeles manager for the company.

In his new post, Mr. Fiske will represent the company in matters having to do with electronic control devices for resistance-welding equipment, which is widely used in many war industries, notably aircraft manufacture.

Born in San Francisco on March 1, 1917, Mr. Fiske attended grammar school in Coulterville, high school at Sonora, and the Modesto Junior College, Modesto, before beginning engineering studies at the University of California. He joined Westinghouse at East Pittsburgh, Pa., in mid-1941, as a graduate student, soon after receiving his Bachelor of Science degree at the University.

In November 1941 he was assigned to the general sales department at East

INDEX TO ADVERTISERS

Air Reduction Sales Co. . . . Outside back cover
American Brass Company 193
American Chain & Cable Company, Inc. . . 195
American Optical Co. 201
American Telephone & Telegraph Co . . . 189
Ampco Metal, Inc. 191
Anti-Borax Compound Company 202
Arcos Corp. . . . . Inside front cover
Bastian-Blessing Co. 194
Champion Rivet Company 197
Electroloy Co., Inc. 206
Emerson Electric Mfg. Co. 207
Eutectic Welding Alloys Co. 216
General Electric Co. . . . . Insert 218 & 219
Haynes Stellite Co. 155
Hobart Bros. Co. 153
International Nickel Co. 220
The Lincoln Electric Co. . . . . Inside back cover
The Linde Air Products Company 156
P. R. Mallory & Co., Inc. 196
Metal & Thermit Corporation 203
National Carbide Corporation 198
National Time & Signal Corp. 208
Oakite Products, Inc. 194
Page Steel & Wire Division 195
Ransome Machinery Co. 192
Resistance Welder Mfrs. Association . . . 209
Sciaky Bros. 217
Shawinigan Products Corp 202
Una Welding, Inc. 205
Union Carbide and Carbon Corp. . 155 & 156
Victor Equipment Co. 211
Westinghouse Elec. & Mfg. Co. 199

. . . . A necessity where *Wear Resistance* is important

When overlaying bearings, shafts, wear strips, and slides—where strength and resistance to wear is important—the excellent bearing characteristics of Ampco-Trode electrodes assure longer life. Made from Ampco Metal, long recognized by American Industry as an alloy for severe service applications, this coated-bronze weldrod has good strength and high ductility in addition to other values. Its wear resistance has been proven in many applications.

These electrodes are a most satisfactory means of metallic arc welding aluminum bronze, and copper alloys containing zinc as a major constituent. They are unequalled in welding on clean cast iron, steel and nickel alloys.

Ampco-Trode weldrods are made in 7 grades. Diameters are ⅛" to ½". Suitable for metallic arc, carbon arc, and oxy-acetylene welding.

You are invited to send for the Ampco-Trode catalogue today, giving full information about this coated bronze electrode.

AMPCO METAL, INC.
Department WJ-3 Milwaukee, Wisconsin

Pittsburgh as application engineering correspondent, a post he held until his transfer to Los Angeles. In May 1942 he completed graduate engineering studies at the University of Pittsburgh.

P. D. McELFISH

Kilsby and Graham of Los Angeles, Calif., announce the addition of Mr. P. D. McElfish to their organization as metallurgical and engineering representative.

SUBSTITUTES

Substitutes, by H. Bennett, is a handbook of substitutes and alternatives for chemicals, metals, fibers and other commercial products, including a plan for choosing proper substitutes.

It is the concentrated essence of many years of experience of many chemists, engineers and other technical workers. Published by Chemical Publishing Co., Inc., Brooklyn, N. Y. Price $4.00.

THE PRINCIPLES OF METALLOGRAPHIC LABORATORY PRACTICE

The Principles of Metallographic Laboratory Practice, by George L. Kehl, B.S., M.S., Lecturer in Metallurgy, Columbia University. Second Edition. Published by McGraw-Hill Book Company, Inc., New York and London. 453 pages, price $4.00.

In this volume the author attempts to fill what is believed to be a very definite need for a text-book of fundamental principles involved in metallographic laboratory practice—a book that will bridge the gap between theoretical physical metallurgy and its practical application in the laboratory.

As the title implies, this book is primarily a treatment of laboratory principles. In many instances, however, the statement of principles has been supplemented by explicit recommendations and precautions so that many important laboratory manipulations will be properly executed. Wherever it seemed desirable, the author has illustrated, side by side, the results of proper and improper techniques and the effects of correct and incorrect procedures.

OBITUARY

Frank M. Denton, 43, superintendent of welders at a magnesium plant in Spokane, Wash., died of a heart attack at his home, on December 22nd. He is survived by his widow and two children. Mr. Denton was a member of the AMERICAN WELDING SOCIETY since early 1941 when he was located in Dallas, Tex.

STANDARDS PUBLICATIONS

NEMA announces the release of a new publication *Electric Arc Welding Machine and Electrode Standards*, Publication No. 42-81, superseding No. 36-37 on the same subject, issued in 1936.

This handbook constitutes a complete revision, the new material covering standards for both the d.-c. and a.-c. arc welders. The standards for rectifier arc-welder equipment remain much the same.

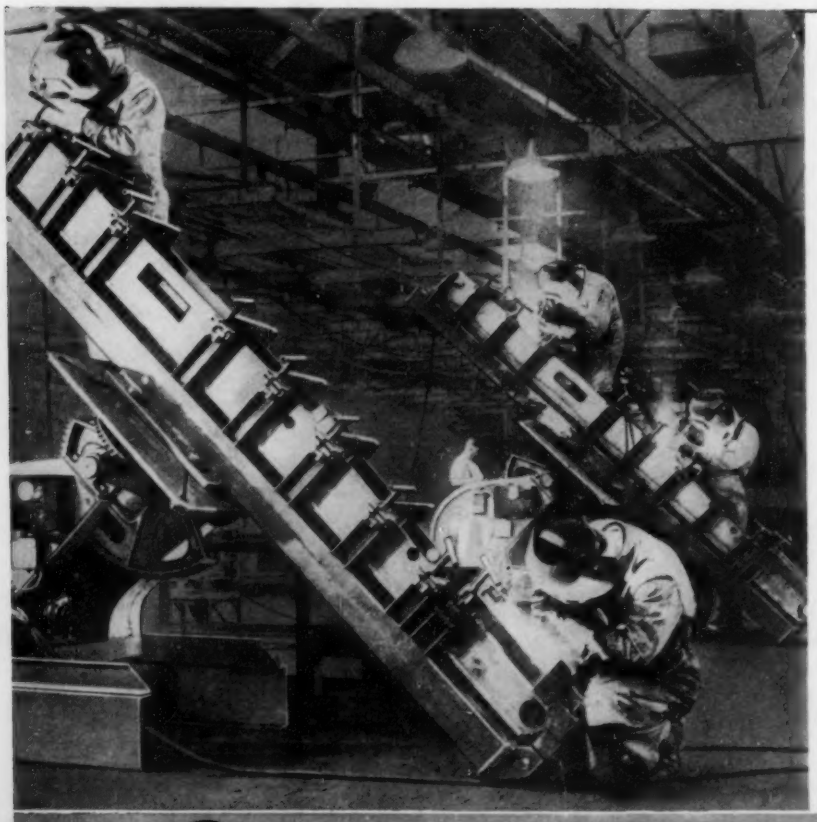
The changes and additions to the d.-c. welder section cover: service conditions; motor starting and generator control equipment; current ratings and current adjustments of multiple operator welding circuit control panels and resistors and reactors for use with these panels.

Changes or additions to the a.-c. welder section include: temperature rise; range of operation; current adjustment; short circuit current; control apparatus; panels; terminals; housing; and dielectric tests.

The standards for electrodes have been segregated and to them has been added a table for two-color markings for heavy coated ferrous electrode identification.

The price is 75¢.

Write to the NEMA Engineering Department, 155 East 44th St., New York City.



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means better welding and greater output...

These two Ransome Welding Positioners are part of a battery of over 90 units in one war plant. Other manufacturers have installed even larger numbers of these production-boosting machines... and reports from many users constantly add to the evidence that this equipment is making good in a big way.

The reasons are simple . . . Rapid handling of work regardless of shape or size . . . Conservation of workers' time and strength . . . And a downhand position for every weld, definitely increasing output, reducing costs, and producing higher quality welds.

Available in all capacities, up to 20 tons.

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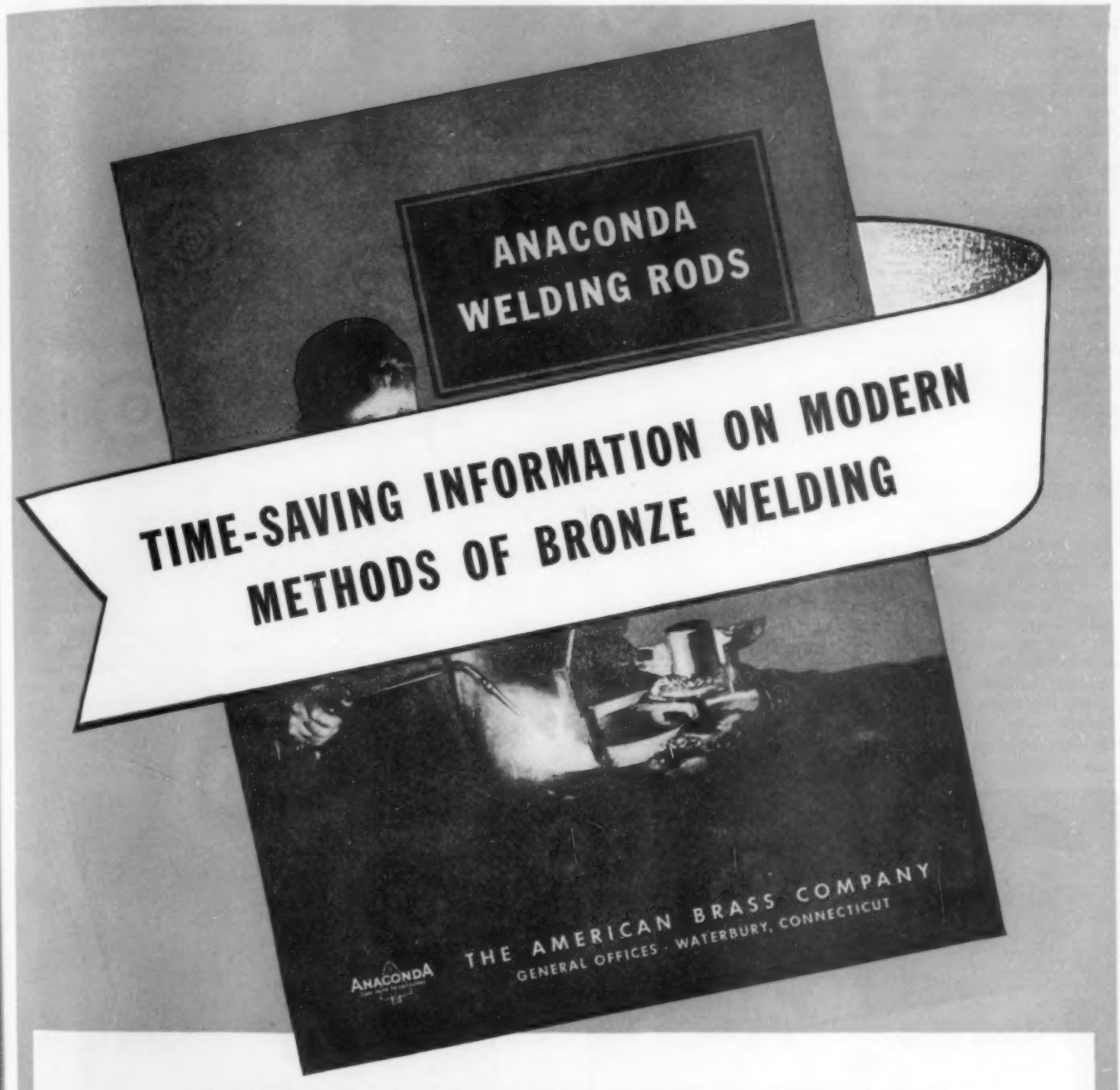
INDUSTRIAL DIVISION • RANSOME MACHINERY COMPANY • DUNELLEN, NEW JERSEY



New Anaconda booklet covers practices to follow, types of rods to use, welding rod compositions, melting points

So extensive has the use of Bronze welding become in recent years, that Anaconda Welding Rods have been adopted as standard materials for oxy-acetylene repair and construction work in many fields. Electric welding of copper alloys has also made tremendous strides. To assist you in keeping up-to-date on construction and repair welding with copper alloy welding rods, you should have this latest edition of Anaconda Publication B-13. It's free for the asking.

ANACONDA

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

Subsidiary of Anaconda Copper Mining Company • In Canada: ANACONDA AMERICAN BRASS LTD., New Toronto, Ontario

PROGRESSIVE APPOINTMENT

Appointment of Walter Moehlenpah as field welding engineer covering Missouri, Southern Illinois, Western Indiana, Southeast Kansas, Southeast Nebraska and Southwest Iowa has been announced by J. R. G. Harris, Sales Manager, Progressive Welder Company, 3050 E. Outer Drive, Detroit.

Mr. Moehlenpah, recently in charge of marketing of the "Frostrode" refrigerating units designed for use in combination with resistance welding equipment, first joined Progressive Welder Company two years ago.

He is a graduate of Marquette University, with a degree of Bachelor of Electrical Engineering, his education also including five years in Mechanical Engineering at the Milwaukee Evening Technical School.

ARC WELDING CAPABLE OF LIMITLESS PROGRESS

Arc welding is, today, exactly where steel making was ten years ago—at the point where, for the limitless progress of which it is capable, it must step forward from the ranks of the arts into that of the sciences. So says F. J. Hirner, welding specialist for the Harnischfeger Corp., in a recent bulletin, "New Advances in Arc-Welding Equipment Design," in which he outlines the modern goal in equipment design and welding technique.

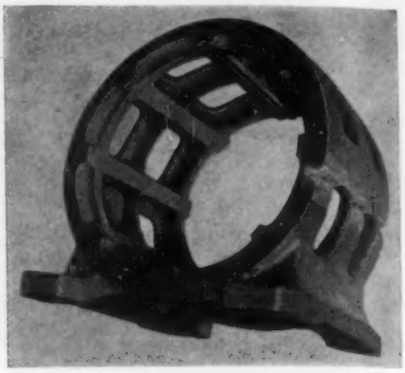
Pointing to the need for greater efficiency in predetermining results in finished welds, and for minimizing dependency upon the human element in applying the process, Mr. Hirner sees simplification of design, control and application of welders and electrodes as the obvious channels for continued advancement. He describes the operating principle of his company's P & H welders as an example of the progress to date toward that goal. Copies of Mr. Hirner's bulletin No. W-20 are available on request to the Harnischfeger Corp., Milwaukee, Wis.

SUGGESTION WINNERS HONORED BY WESTINGHOUSE

Thirty-four employees of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., whose ideas helped increase the production of war equipment and save vital materials during 1942 were recently honored by the company.

Twenty-four of the war workers, one of them a woman, have been awarded a total of $6174.48 for outstanding suggestions that aided the Westinghouse War Production Drive. Their ideas were among 2746 adopted during the year. All told, the company paid employees $25,412.14 under the plan in 1942.

Among those honored was Joseph E. Slick, of the Motor Division, who worked out a faster and more economical method of winding copper coils for arc-welding machines. His suggestion revised the whole operation. For this he received $605.50.



REBUILDING MOTOR AVOIDS USING SPARE

The above illustration show how a 550-hp. motor frame was repaired by brazing at the suggestion of Westinghouse engineers. The shaft, also broken, was mended by making a flanged axle steel plug. This plug was securely pinned and then welded in place. Had the plant used its spare motor to replace the one damaged, it would have been necessary to operate without a spare for a period of 19 weeks.

Is this YOUR Cleaning Problem?
How to Keep Weld Spatter From Sticking
If you are having trouble in keeping weld spatter from bonding in arc, flash and butt welding, here is a tip that will HELP YOU solve this problem easily, quickly...
Before welding, brush, swab or spray surfaces surrounding area to be welded, with mixture of recommended Oakite material and water. You will find that weld spatter DOES NOT STICK! It comes off easily...without grinding or chipping...thus saving you precious man-hours! Moreover, this mixture is readily removed with your regular Oakite cleaning procedure. Details FREE on request.
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Technical Service Representatives Conveniently Located in All Principal Cities of the United States and Canada
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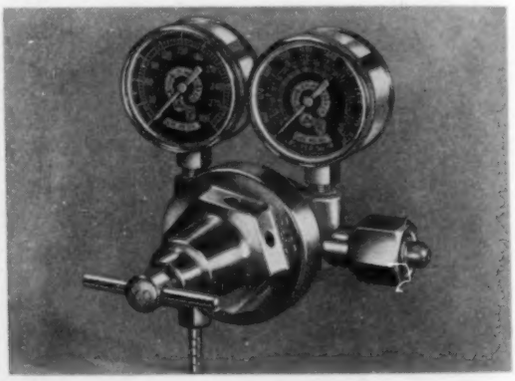

BRASS MAKES BULLETS

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REGO Gas Plant Equipment to be safe, must be made of brass and other critical metals.

Conserve equipment—You may not get more.

The BASTIAN-BLESSING Co.
4241 W. PETERSON AVE. CHICAGO
Pioneers and Manufacturers of Precision Equipment for Using and Controlling High Pressure Gases

Yes, **PAGE** *did* develop an electrode for welding armor—for tank welding. But that achievement was the natural result of a *program*.

As another example, **PAGE** programmed and developed a range of Stainless Electrodes so complete that from it you can select an electrode that is certain to give you a deposit that equals the Stainless you are welding—and in the correct size for economy.

Ask your local **PAGE** Distributor to give you a copy of the valuable 8½x11 booklet on welding Stainless Steel with **PAGE-ALLEGHENY** Stainless.

PAGE **WELDING ELECTRODES**

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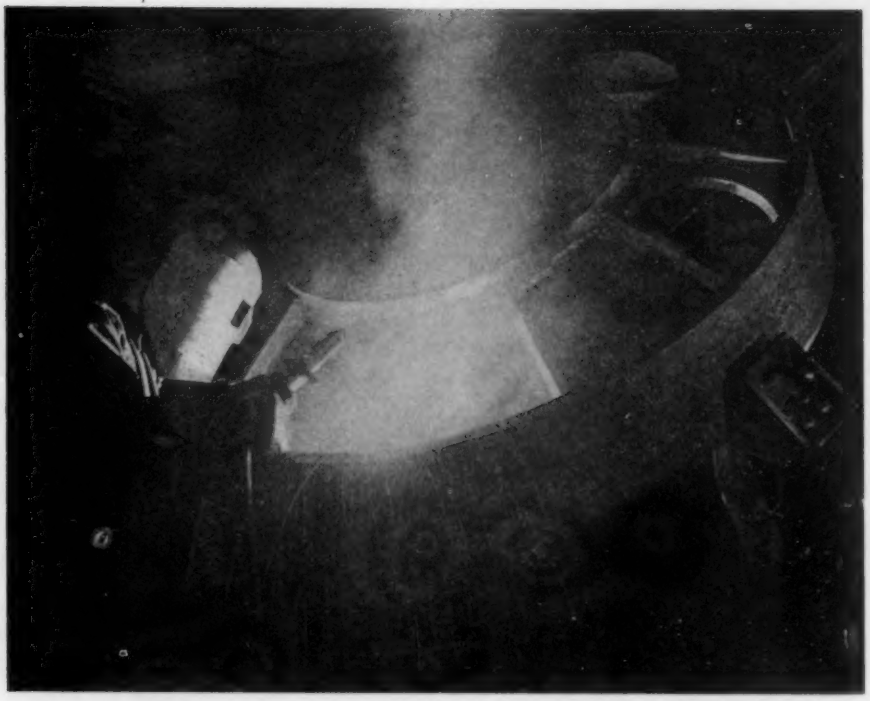
ESSENTIAL PRODUCTS . . . TRU-LAY Aircraft, Automotive, and Industrial Controls, TRU-LOC Aircraft Terminals, AMERICAN CABLE Wire Rope, TRU-STOP Brakes, AMERICAN Chain, WEED Tire Chains, ACCO Malleable Castings, CAMPBELL Cutting Machines, FORD Hoists, Trolleys, HAZARD Wire Rope, Yacht Rigging, MANLEY Auto Service Equipment, OWEN Springs, PAGE Fence, Shaped Wire, Welding Wire, READING-PRATT & CADY Valves, READING Electric Steel Castings, WRIGHT Hoists, Cranes, Presses . . . *In Business for Your Safety*



WELDING MARINE COUPLINGS

Photo shows the making of fillet weld between the center plate and the outside rim on a marine electric coupling developed by Westinghouse to replace mechanical flexible couplings. Diesel engine torque and the pulsation are eliminated by the transmission of power from an energized field to rotor rather than by the contact of mechanical parts. Smooth maneuvering of ship is accomplished by the energizing or de-energizing of the desired couplings. The electrically operated positioner which turns the assembly while the welder is working saves one-fourth of time as required by cranes and by hand.

DATA ON CORROSION-RESISTING AND HEAT-RESISTING STEELS

The new tables of data on Chemical Compositions, Physical and Mechanical Properties of Wrought Corrosion-Resisting and Heat-Resisting Chromium and Chromium-nickel Steels published in December 1942 by the American Society for Testing Materials have been under development for many months by Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys. Messrs. Franks and LaQue carried out the work for the committee, with data contributed by a number of manufacturers and users of stainless steel. An effort has been made to give the data in condensed form and to cover material in widest commercial usage. The first part pertains to wrought chromium steels, 4 to 6%, 8 to 10% chromium, etc., while the second part covers wrought chromium-nickel steels up to 25% chromium, 20% nickel. All told there are 21 extensive but compact tables and 26 charts and curves covering important data such as chemical composition, physical properties, forging and heat-treating practices and mechanical properties of steels. There is information on creep characteristics and short-time tensile properties. This latest publication is the third in the series on stainless steels issued through the work of the Society—the first two having been published in 1924 and in 1930.

Copies of the 44-page pamphlet can be obtained from the A.S.T.M. Headquarters, 260 S. Broad St., Philadelphia, Pa., at $1.25 per copy.

HOW TO FIGURE ARC WELDING SPEED

A circular on this subject has been prepared by H. O. Westendarp, Jr., welding engineer of the General Electric Company, Schenectady, N. Y. The pamphlet also describes the use of the new General Electric Arc Welderule. Copies of the circular may be obtained on request.

NEWELL RECEIVES MOREHEAD MEDAL

Harry Edmund Newell, assistant chief engineer of the National Board of Fire Underwriters, New York City, was awarded the James Turner Morehead Medal for 1941 for his "leadership in developing standards for installation and operation of acetylene equipment and systems."

The Morehead Medal is given annually by the International Acetylene Association in honor of the late James Turner Morehead, who sponsored the experiments which led to the discovery in 1892 of the modern electric-furnace method of producing calcium carbide, from which the acetylene industry has sprung. The medal is awarded for outstanding work in the acetylene industry or for advancements in the production or use of calcium carbide or acetylene.

Present at the award dinner held at the Union League Club Jan. 25th, was the Hon. John M. Morehead, former Minister to Sweden, who established the award in 1922 in honor of his father. The medal was presented to Mr. Newell by Henry Booth, past-president of the Association. Mr. Ellsworth L. Mills, President of International Acetylene Association presided.

Mr. Newell has been affiliated with the National Board of Fire Underwriters since 1909, most of this time working with the Committee on Fire Prevention and Engineering Standards. His engineering work began with employment as a rodman on the Delaware, Lackawanna and Western Railroad, followed by mining work in Cuba and two years with the U. S. Army Engineers on coastal and harbor surveys.

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The men who man high speed spot welding guns, single and multiple spot welders, seam welders and flash welders . . . rely on Mallory for long life electrodes! Write for your free copy of the factual Mallory Resistance Welding Data Book . . . today.

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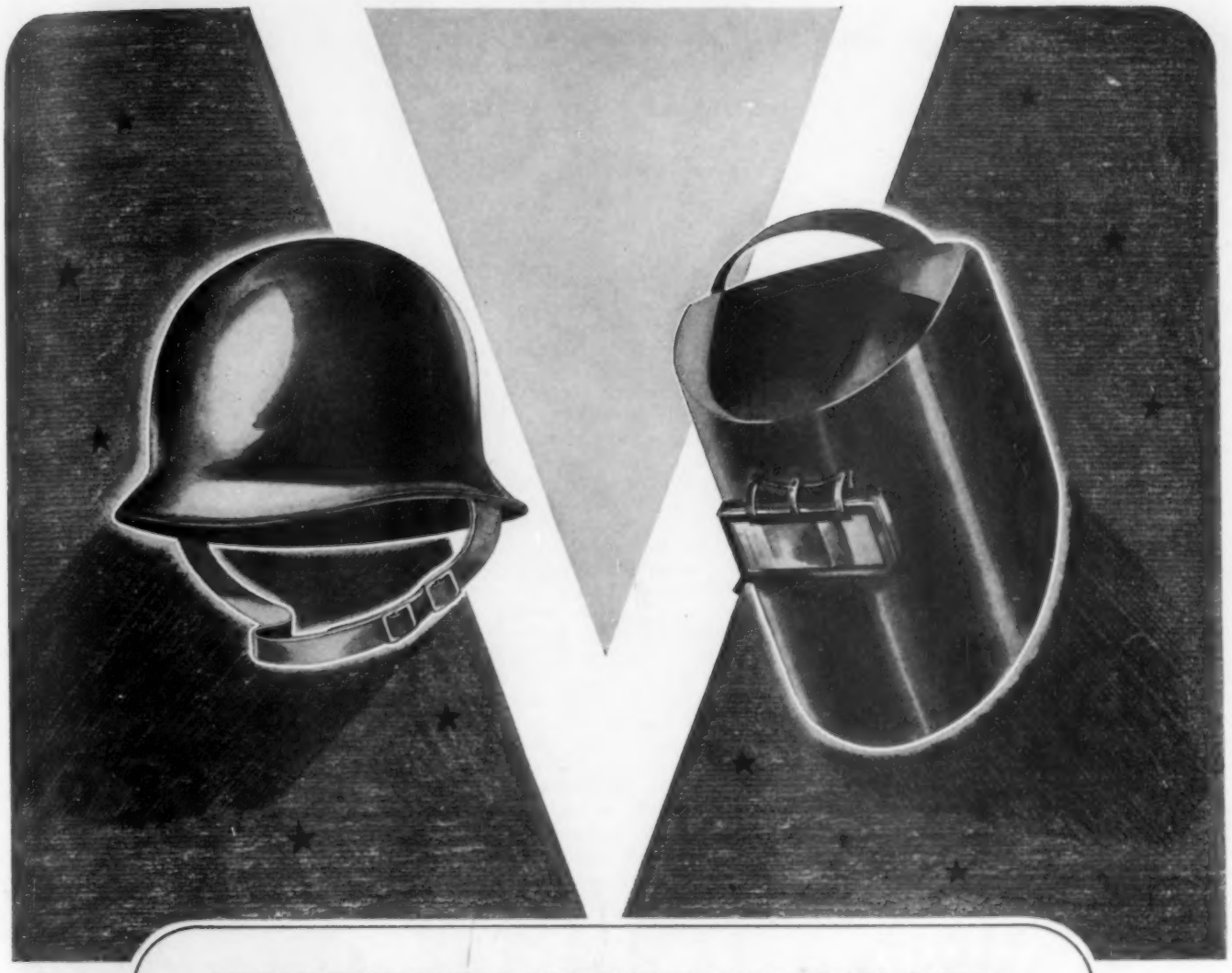

WHAT THE WELL DRESSED MAN WILL WEAR *This Year!*

Helmets are the style again. On the firing line and the production line two-fisted men favor this Victory headgear. To the many new wearers of welder's helmets we would like to say a word on Champion electrodes.

Whenever you use Champions you may be sure of welds which will pass the most rigid inspection. Welds done better and in less time — welds uniform and smooth. There is a size and length for every job — use the largest practical size thereby saving vital critical materials. Be sure and burn them down to shortest stub end.

Send for a copy of our new catalog.

THE CHAMPION RIVET COMPANY

11400 HARVARD AVENUE • CLEVELAND, OHIO

EAST CHICAGO, INDIANA

Harry Edmund Newell (Left) Is Presented with the James Turner Morehead Medal, Annual Award for Achievement in the Acetylene Industry, by Henry Booth, Past-President of International Acetylene Association

This, together with nation-wide work in inspecting cities for fire hazards formed a background of first-hand knowledge that has been invaluable in his cooperative work with industries on fire prevention and safety work.

As Engineer, committee member and chairman, Mr. Newell has been mainly responsible for the establishment of standards for the installation and operation of acetylene equipment and systems. Without these regulatory features, the usefulness of acetylene to industry—and especially to the war production program—might have been substantially retarded. These standards, the growing result of years of persistent engineering investigation and study, have thus helped make possible the widespread use of acetylene. Some of its more familiar applications include such vital wartime processes as oxyacetylene cutting in the preparation of steel plates for ship, tank and gun parts, oxyacetylene welding in aircraft construction; and also its use as a base for the manufacture of chemicals, including certain types of synthetic rubber.

Mr. Newell's engineering and research results have been widely published in the technical press and in booklet form. He has been prominent as a speaker on the subject of fire protection before many engineering and civic bodies.

In addition to being an honorary member of the International Acetylene Association, Nr. Newell is a member of the American Society of Civil Engineers, and the National Fire Protection Association, and is active in the affairs of the American Standards Association. For the last eight years he has held the office of the mayor of his home city, Bloomington, N. J.

Previous recipients of the Morehead Metal have included Edmond Fouché, French scientist and developer of the oxyacetylene torch; Samuel Wylie Miller, pioneer in promotion of welding engineering; Nils Gustav Dalén, the blind Swedish scientist and Nobel Prize Winner; and the late Father Julius Nieuwland of Notre Dame University, who developed one type of synthetic rubber from acetylene.

HOOD HONORED

C. F. Hood, president of American Steel & Wire Co., accepts a 25-yr. silver U. S. Steel Corp. service medal from John May, vice-president and general manager of sales of the Wire Co. The presentation was made at a joint dinner meeting of the sales and operating personnel of the company in Cleveland, Ohio.

Mr. Hood first started working for the Wire Co. in May 1917 as an operating clerk at Worcester, Mass. He worked his way up through the ranks until on January 1, 1938, he became president of the company.

National

Carbide

IN THE RED DRUM

EFFICIENT

ECONOMICAL

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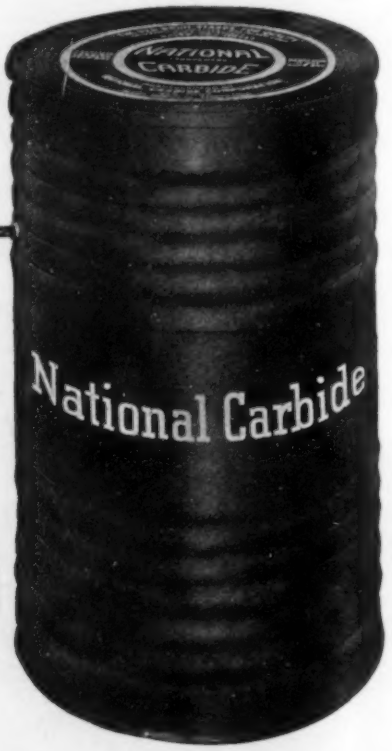
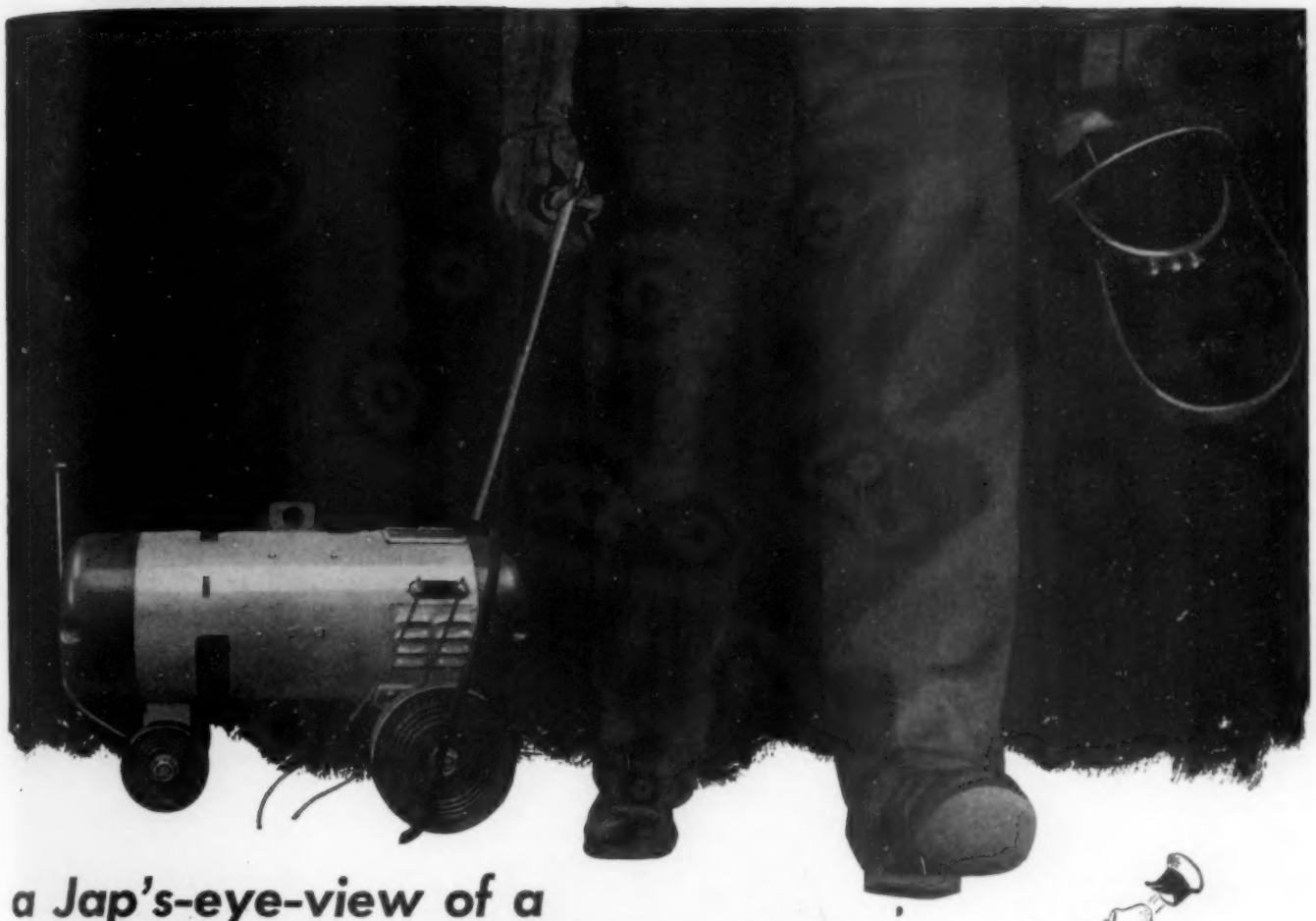


FOR WELDING and CUTTING

Use National Carbide in the Red Drum

60 E. 42nd St. NATIONAL CARBIDE CORPORATION New York, N. Y.



a Jap's-eye-view of a

WAR WEAPON

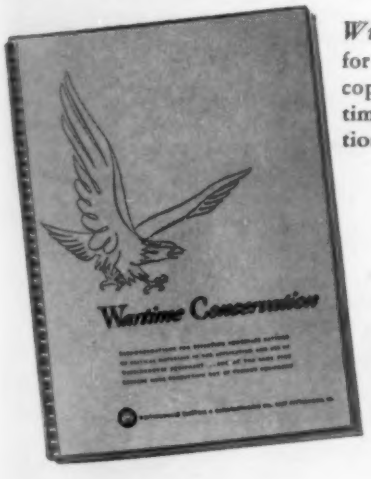
SAVE CRITICAL MATERIALS in selection, application and use of electrical equipment.

USE NEWLY DEVELOPED METHODS to speed vital war production.

KEEP EQUIPMENT RUNNING by proper Maintenance and Repair Service.

REPLACE CRITICAL MATERIALS with Micarta and Prestite.

SAVE SCRAP by systematic planning and salvage.



Write today for your free copy of War-time Conservation, B-3206.

When "sunken" ships come sailing back and "crashed" planes deliver another stick of bombs, the Japs must look with awe on the "weapon" that gives these damaged ships new life. This "weapon" is electric welding. By speeding fabrication and repair, this amazing process is speeding Victory.

There still remain, however, many places on the production front where the latest welding techniques are not being used to full advantage. Westinghouse suggests that you investigate them immediately.

One new process stitches steel together automatically 20 times faster than any other method. Another type of unit requires 30% less critical materials to build, eliminates troublesome arc-blow.

These and other methods of speeding war production and saving critical materials are suggested in the new 100-page book, "Wartime Conservation." Write for your free copy today. Address nearest office or Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

J-21268

Westinghouse

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Employment Service Bulletin

SERVICES AVAILABLE

A-447. Welding Engineer and Instructor available. Have had eleven years' teaching experience, chiefly in welding, in connection with engineering university and high school courses. Have had three years of practical welding experience. 36 years of age. Draft status 3A. Married. One child.

A-448. Welding Engineer available. 55 years of age. Graduate Columbia University 1911. Experienced as draftsman, assistant engineer Public Service Commission, on sewer design and reconstruction, field work for installation of track equipment. Designer on structural work such as sash and steel partition. Sales Engineer for past ten years or more, particularly in structural engineering field.

A-449. Young Engineer with shipbuilding firm desires position in practical product production and fabrication of special equipment and structures. At present employed with a southern shipyard. Single. Age. 27. Graduate of MIT Class '37. Majored in Metallurgy and Electrochemistry. Has held position as Sales Engineer with Joseph T. Ryerson & Son; Assistant Head of the Suggestion Department of United Shoe Machinery Corp. Present position Assistant to Welding Engineer, shipyard.

A NEW, CORROSION DATA WORK SHEET

A New, Corrosion Data Work Sheet has been designed to assist executives and engineers in their study of corrosion problems. The Work Sheet acts as a check list to insure consideration and evaluation of all factors influencing a corrosive action. It also permits ready comparison of a problem with similar ones which may be used as a guide for selecting materials possessing a satisfactory resistance. This form distributed by The International Nickel Company was developed by its Technical Service as a result of extensive experience with corrosion data inquiries that inadequately described conditions for which recommendations were sought.

Copies of the Corrosion Data Work Sheet may be obtained without charge from Technical Service. The International Nickel Company, 67 Wall Street, New York N.Y

NEW LOS ANGELES OFFICE FOR HANDY & HARMAN

Handy & Harman of New York, leading fabricators of silver and gold alloys, announced the opening of a Los Angeles office. The company states that the need for this office has been brought about principally by the rapid growth in the use of their silver brazing alloys Sil-Fos and Easy-Flo in the construction of ships and airplanes. Mr. H. A. Folgner, connected for many years with the company's Brazing Engineering Division in New York, has charge of the office, which is located in the Bendix Building, 1206 South Maple Avenue, Los Angeles. From this location the company will be in a position to improve their service to shipyards, airplane plants and other factories and to cooperate more closely with dealers on the West Coast. The new office also provides a service headquarters for those using gold and silver in making products for the arts.

BRAZED ENDS MAKE WIRE ROPE SAFER TO HANDLE

By F. L. Spangler*

Where clip fastenings or other means of attachment are used that expose the end of a wire rope, there is constant danger that those handling the rope might receive lacerations or puncture wounds from the sharp wires at the rope end. This form of injury is said by some medical authorities as being especially dangerous since it is likely to be deep seated, and the injured man might consider the wound as too superficial to require immediate attention. It is not uncommon for blood poisoning to develop from such wounds where immediate treatment is not given. And now that we need every ounce of production energy—this is no time to have workmen laid up because of injury.

A simple method of eliminating the hazard of sharp exposed rope ends is to braze the end of the rope with a bronze welding rod, running the bronze back for a distance of an inch or two from the end.

* M.E., Member, American Society of Safety Engineers.

The Red Cross has Problems like your own

—of Planning

Your Red Cross operates a vast planning program to enable it to be ready for any disaster or emergency anywhere—whether it comes in the Americas, Europe, Australia, Asia, or Africa.

—of Organization

Your Red Cross is responsible for the smooth operation of 3,750 chapters and 6,000 branches, all engaged in the same enterprise of helping all who need help.

—of Personnel

Your Red Cross has tripled its staff since Pearl Harbor and has had to enlist the aid of and train over 6,000,000 volunteers in the principles of First Aid, Water Safety, Accident Prevention, Home Nursing, Nutrition, Nurse's Aideing, Mass Feeding, Motor Mechanics, and other subjects allied to our country's war effort.

—of Production

Your Red Cross is not only one of the world's foremost purchasers of supplies, but it has the immense distribution job of collecting millions of items from 10,000 different communities in the United States, assembling and storing them, and then shipping them to practically every country in the world. Last year your Red Cross shipped some $60,000,000 worth of food, clothing, and medical supplies to over 20,000,000 homeless people in foreign countries.

—of Finance

Your Red Cross, whose war-time and post-war expenses will run well into hundreds of millions, must account to the public for every penny it collects and puts to work. Its accounts are audited annually by the U.S. War Department.

The Red Cross faces the same problems as are in your business. With your support it can successfully meet them.

The Second War Fund is greater than the First, but no greater than the increased needs.

Business men can help with time and with money, as organizations and as individuals.

March is the Red Cross month ... Cooperate with your Red Cross Chapter.

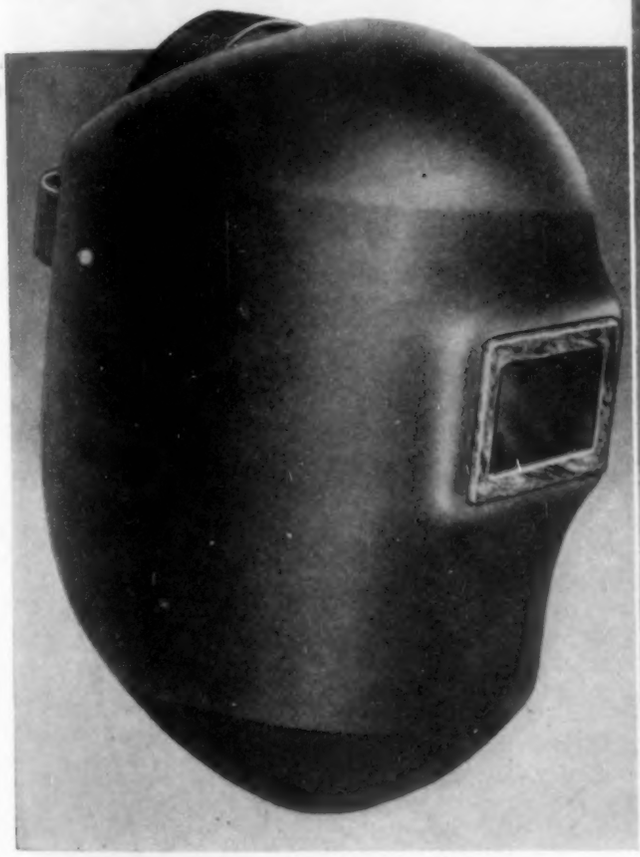
Your Dollars help make possible the

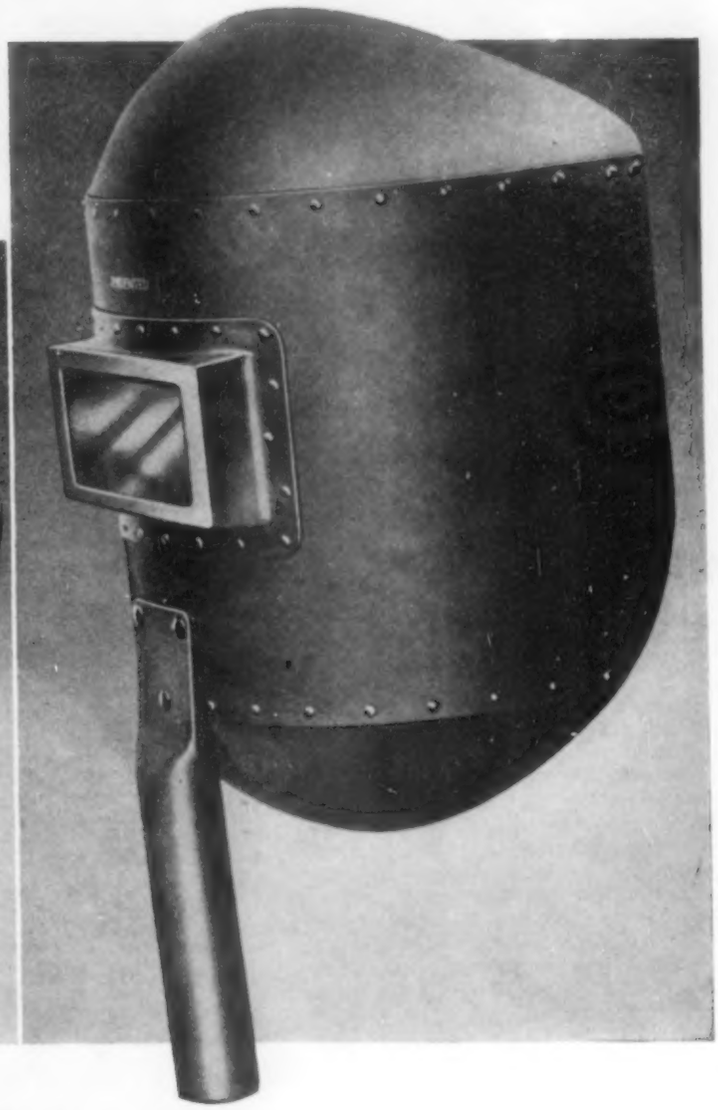
AMERICAN RED CROSS

This space contributed by the Publisher

Filterweld* Welding Plates

developed by AO Research for your HELMETS and HANDSHIELDS





...available in Six Shades

AO Filterweld* Welding Glass, scientifically controlled in production, with fixed standards of densities to conform with U. S. Bureau of Standards Specifications, is now available, *without waiting,* for your helmets and handshields. Filterweld* is a service-proved welding glass that absorbs 100% of the ultra-violet rays and more than 99% of the dangerous infra-red rays. It can be obtained in six shades—Nos. 8, 9, 10, 11, 12, and 13. For your Filterweld* Welding Plates, get in touch with your nearest American Optical Branch Office.

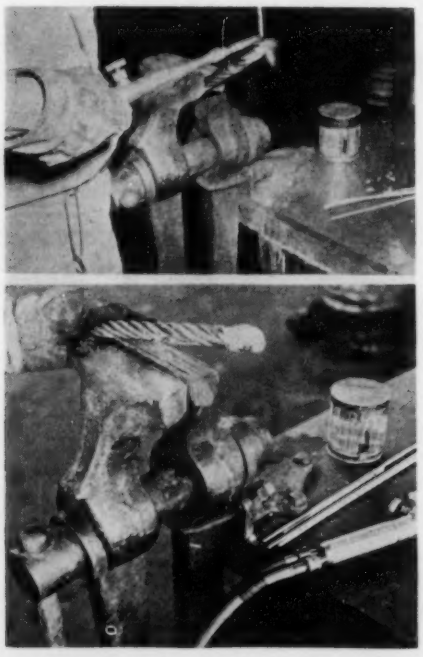
*T. M. Reg. U. S. Pat. Off.

American Optical

COMPANY

SOUTHBRIDGE, MASSACHUSETTS

Covering the Sharp Wires at the Rope End by Applying Bronze with a Welding Torch



With the End Bronze Welded the Wire Rope Can Be Handled Without the Hazard of Lacerations and Puncture Wounds Caused by Exposed Wire Ends

When properly done, the bronze covers all the wire ends, and it also has the advantage of holding the rope end intact so that seizings can be removed.

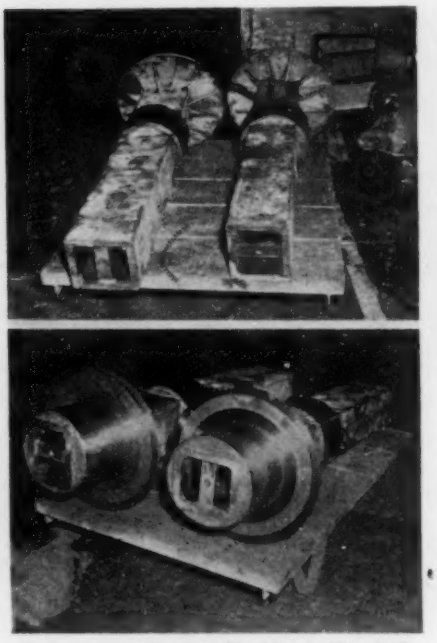
Ends of preformed ropes can be brazed without applying a seizing beforehand, since preforming removes all unbalanced stresses in the rope wires and strands so all wires hold their position in the rope without the need for using seizings. Even so, a single seizing will insure that the rope construction will not be flattened during the cutting operation. If the rope is not preformed, it is recommended that two or three seizings be applied—one close to the end of the rope and the others a short distance (4 to 6 in.) apart.

Where end brazing is done, either the same torch or a cutting torch may be used to sever the rope before bronze is applied to the end.

CONSTRUCTION OF MAST COLUMNS FOR HEAVY CRANES

Greatly simplifying the construction methods, arc welding has made possible the fabrication of these mast columns for heavy-duty cranes at The Cardwell Mfg. Co. of Wichita, Kan.

The columns, as shown in the illustrations, are fabricated from 8- x 8- x 1-in. angles, with two corners welded together to form square box sections. The two bearing surfaces are formed from $^5/_8$-in. plate welded onto the column and then machined. The plate, on which the gussets end, is $^3/_4$ in. thick, and the gussets themselves are $^3/_8$ in. in thickness.



Courtesy The Lincoln Electric Co.

Describing this new method of construction, The Lincoln Electric Co. of Cleveland, pointed out that such masts were formerly machined from solid material. If they had been made of a solid piece of steel, 50% of the original material would have been wasted, in addition to the enormous amount of labor that would have been necessary.

They could have been forged in normal times, but the demands upon forge shops are so great that months would have elapsed before any forge shops could have touched them.

The cranes for which these columns are made are used for handling airplane engines and other heavy equipment in the field of combat.

ARC WELDING IS SPECTACULAR

Courtesy The Lincoln Electric Co.

Arc welding is spectacular as well as one of the most useful arts in America's war effort, as this unusual photograph testifies.

The welder here is fabricating a massive steel pedestal at the Bentley Weldery, Inc., Syracuse, N. Y. The sparks are given off as the intensely hot electric arc fuses the metal.

This is one of the thousands of welding operations that is helping to speed up war production—the production of cargo ships, warships, submarines, tanks, tank destroyers and other munitions of war. Welding, for example, has helped to reduce the construction time of a cargo ship from 200 days to 111 hours, and helped the United States turn out as many as four cargo ships a day.

Buy "Proven Fluxes" with Years of Guaranteed Satisfaction behind them
The Trade-Name is "ANTI-BORAX"

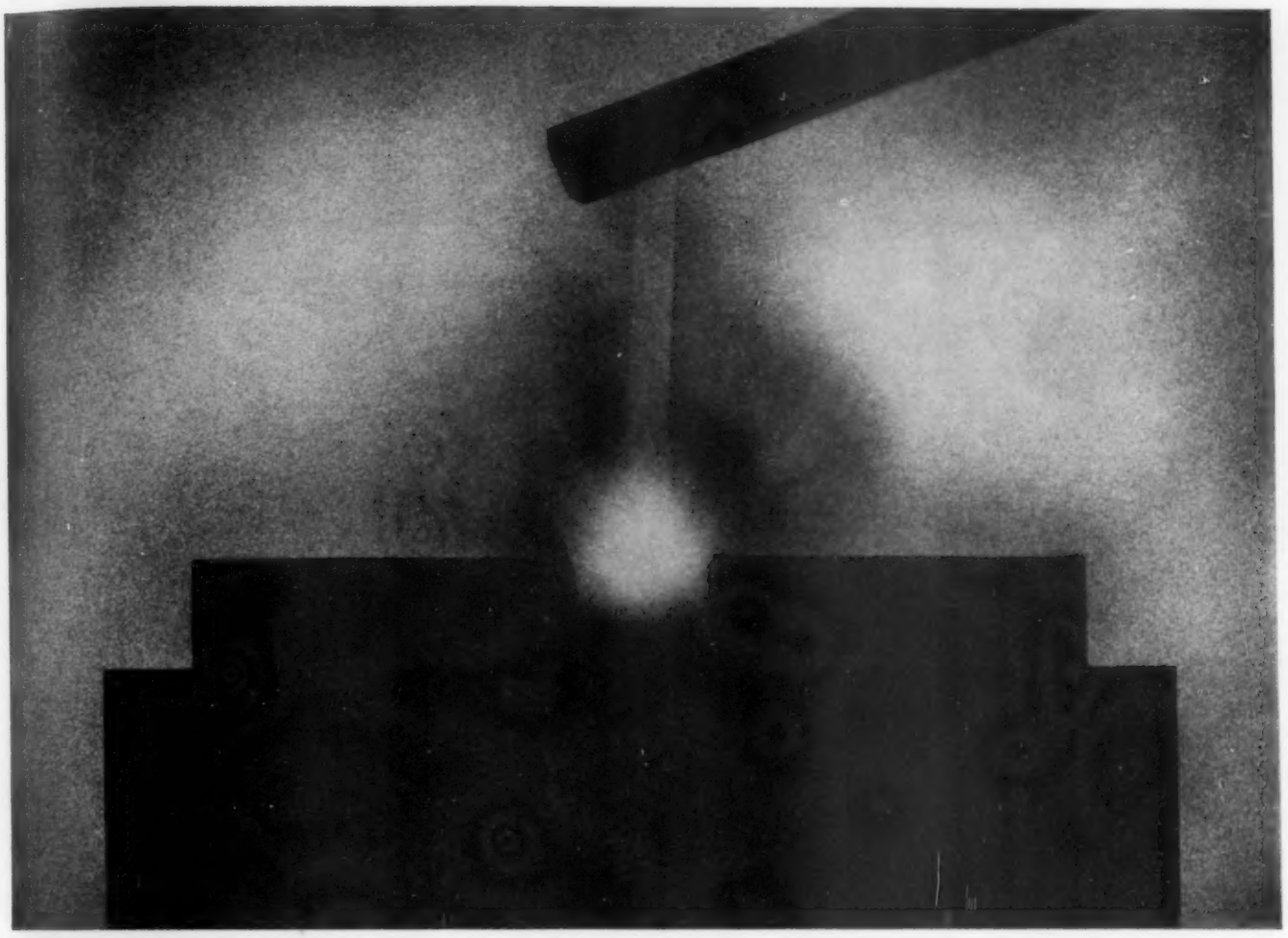
Ask for Them ***Unequalled for Quality***

A Flux for every metal: Cast Iron Welding Flux No. 1; Brazing Flux No. 2; Braz-Cast Flux No. 4, for bronze-welding cast iron; "ABC" Aluminum Flux No. 8 for sheet Aluminum and all alloys of Aluminum; Stainless Steel Flux No. 9; Silver Solder Brazing Flux No. 10; "Anti-Borax" Tinning Compound No. 11.

ANTI-BORAX COMPOUND COMPANY
Fort Wayne, Indiana

You'll do it better with
SHAWINIGAN CARBIDE

SHAWINIGAN PRODUCTS CORPORATION
EMPIRE STATE BLDG., NEW YORK



IN MAKING PLUG WELDS AND BOSSES CHANGE RODS BEFORE METAL AND SLAG COOL

BY USING the proper technique in making plug welds and bosses, it is possible to deposit a minimum of weld metal and save time besides. *It is not necessary to clean slag between layers. Burn the rod right down to the stub-end and start the new electrode quickly before metal and slag cool.* ¶ In spite of a nearly 80% increase in 1942 electrode production over 1941, the demand still exceeds the capacity of the industry to produce and every precaution for saving electrodes must be taken. ¶ We will gladly send you, without charge, reprints of the series of advertisements on this vital subject for posting in your welding department.

METAL & THERMIT CORPORATION

Specialists in welding for nearly 40 years. Manufacturers of Murex Electrodes for arc welding and of Thermit for repair and fabrication of heavy parts.

MUREX ELECTRODES

120 BROADWAY, NEW YORK

ALBANY • CHICAGO • PITTSBURGH
SO. SAN FRANCISCO • TORONTO

NEW PRODUCTS

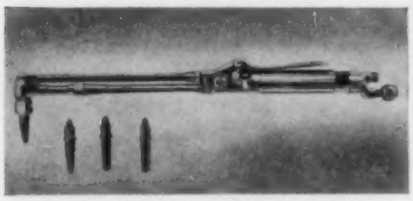
The Society assumes no responsibility for the validity of claims in this Section

CUTTING TORCH

To meet today's demands this new torch is rugged, fast and will handle, in addition to regular plate cutting, such jobs as hole piercing, cutting rusty multiple plate, billet deseaming, cast iron and rivet washing.

New mixing principle provides fast preheating, and oversize high-pressure oxygen passage permits unrestricted flow of cutting stream to enable fast economical operation on all metal thicknesses.

Leak-proof high-pressure oxygen valve is made possible by the diaphragm which replaces packing ordinarily used. The smooth action of this valve permits "easing in" of the oxygen cutting stream to give better starting control.



Stainless steel oxygen and acetylene needle valves are non-seizing, non-scoring to provide sensitive and positive preheat flame adjustment.

A new cutting attachment for use with standard Rego welding torches is also available. It has essentially the same operating and construction features which are found in the big model NC cutting torch.

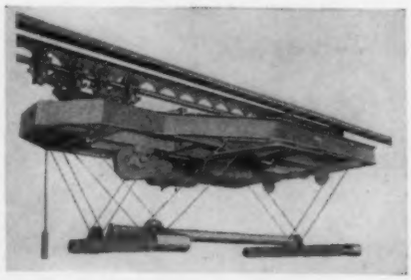
A 4-page bulletin fully describing this new torch and the four series of tips used is available upon request from National Cylinder Gas Co., 207 W. Wacker Drive, Chicago, Ill.

TRAMRAIL CARRIER

The Cleveland Tramrail Division of The Cleveland Crane & Engineering Co. announce a new Stabilized Tramrail Carrier that solves one of the oldest problems in hoisting—that of suspending a load rigidly with the use of the usual flexible hoisting ropes.

A load can be raised or lowered through a considerable distance and yet, with nothing more than the hoisting ropes supporting it, will remain as rigid as if guided in an elevator shaft. Further, even if the load should be considerably unbalanced, the carrier will hold it rigidly in place.

Another very desirable advantage of the carrier is the feature permitting the tilting of a load in either direction with relation to the rail on which the carrier is



propelled. If it is desirable to rotate the load, this may be accomplished through use of a trunnion-type load bar. Thus in most cases it is possible to place any part of a load in any position that will be most convenient and accessible.

The stabilized carrier offers possibilities for many applications including:

Supporting welding equipment for applying long continuous welds automatically.

Welding positioner.

Handling X-ray equipment used for inspecting welds.

Stabilized carriers have been built for capacities of one, three and five tons, some hand propelled and some electrically propelled, but all with motor-driven hoist. They may be built for various capacities and speeds to suit individual requirements.

STANDARD FLASH-WELDER LINE

The first of a series of standardized flash welders has been announced by Progressive Welder Company, Detroit, thus further expanding that company's line of products which now includes all forms of resistance-welding equipment from guns and fixtures to seam, projection, rocker-arm and pedestal-type welders, etc.

Outstanding features of the new standard Model "C" flash welder, rated at 150 kva., is the incorporation of a "Flash-trol" monitor which provides an automatic weld-quality control by eliminating short circuiting of the flash-welding arc.

The "Flash-trol" unit is based on the application of an electronic device which "warns" the machine of an impending short circuit in the welding arc. The instant this happens, the forward movement of the feed platen is interrupted, the platen jumps back a few thousandths of an inch and then reapproaches.

The device makes possible a higher than normal rate of acceleration of the feed platen while performing the weld, thus insuring that the maximum rate of weld completion is automatically employed, without the danger of incomplete welds or line overloads due to short circuiting.

This not only insures maximum production speed but also improves weld quality in the direction of simplifying the upsetting problem following completion of the weld, since, in flash welding, a maximum speed and force of upset are desirable.

MULTIPLE-OPERATOR WELDING MACHINES

A new type of low-voltage electric-current supplying equipment is being manufactured by the Hanson-Van Winkle-Munning Co. of Matawan, N. J. This equipment is the multiple-operator welding machine, designed especially for use in shipyards to enable a large group of welders to work from one motor-generator set instead of having an individual motor-generator set for each welder. Its primary purpose is to facilitate faster and better shipbuilding.

The motor-generator set made by the Hanson-Van Winkle-Munning Co. has a capacity of 1500 amp. at 70 v. It is made in two types—stationary and semi-portable.

In the stationary type, the drive motor can be either a. c. or d. c. If the drive is a. c., the motor can be of either the synchronous or induction type, for 60- or 25-cycle operation. Motors can be of any voltage: 220, 440 or 550 for a. c. or d. c., or 2300 v. for the a.-c. drive. Motor-starter panel and generator-control panel are complete, separate units that must be permently installed.

The semi-portable type is a complete drive and control mounted on a single-bed plate, completely wired and easily accessible. The driving motor can be either a. c. or d. c. If an a. c. drive, it can be either a synchronous or induction motor for 60- or 25-cycle operation. Motors can be of any voltage; either 220, 440, or 550 for a. c. or d. c., or 2300 v. for the a. c. drive.

"FUSE-BOND" PROCESS PREPARES SURFACES FOR METALLIZING ELECTRICALLY

Metallizing Engineering Co. Inc., announces the revolutionary new Fuse-Bond Process and equipment for its application, whereby machine components and similar metal parts now may be prepared for metallizing *electrically*. Main advantage of the process is that it affords an adequate bond on the hardest surfaces, heretofore impossible or impractical to prepare by blasting or rough threading. It also simplifies preparation of narrow edges, flat areas, and cylindrical parts having keyways and other interruptions in their surfaces.

Application of the process is with the Metco Fuse-Bond Unit. Operating on any 110- or 220-volt, single-phase power line, this equipment fuses a rough deposit of electrode metal into the surface to be metallized. Electrodes are applied to the work with a special holder which uses up to six electrodes at a time, depending on

Speed up your Arc Welding for war 200% to 300%

UNAMATIC shielded arc welding is two or three times as fast as manual operation. War production is proving conclusively that wherever it is applied automatic welding yields maximum saving of time, labor and materials.

Faster welding, either in inches per minute or pounds deposited per hour, means more production from available man power. With Unamatic equipment fatigue is eliminated and the welder can work longer, thus again adding to his daily production.

Uniformity and close control of the quality of the weld are inherent in the Unamatic process and its exclusive application of shielded arc principles. Hundreds of Unamatic welding heads are now engaged in war production and our facilities now are wholly devoted to automatic equipment.

Now is the time to familiarize yourself fully with Unamatic welding to speed up your present effort and to let you take on more. Write for catalog today.

CONTROLLED QUALITY

CONTINUOUS PRODUCTION

UNAMATIC WELDING

UNA WELDING INC. • 1615 COLLAMER AVE. • CLEVELAND, OHIO

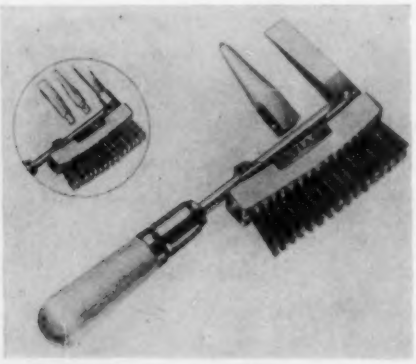
Metco "Fuse-Bond" Unit Type C.

the size and nature of the part to be prepared. Small parts may be prepared with this equipment as easily as large shafts, since there is no excessive heating of the base metal, or disturbing of its physical characteristics.

Further information on the process and its equipment contained in Bulletin 44, obtainable from Metallizing Engineering Co., Inc., Long Island City, N. Y.

CLEANING TOOL

A new and improved weld cleaning tool for welders in shipyards, aircraft and tank plants, boiler and sheet metal shops, and for oil pipe line, factory maintenance and general welding work is now being manufactured under the trade name Dual-Tool by the Atlas Welding Accessories Company, 307 Boulevard Building, Detroit, Mich.

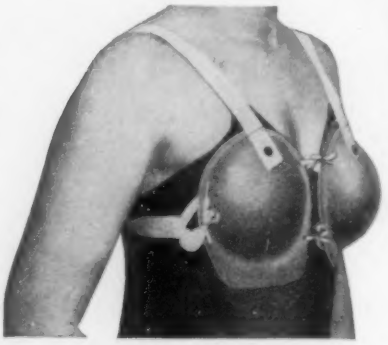


The Dual-Tool combines a wire bristle brush and a slag-removing bit in one unit and features a specially developed brush holder which permits removal of brush for reversing or replacement by inserting screw driver or other sharp object at rear end of holder. An up and outward pry releases tension. Brush pops out. Reverse action for inserting and brush snaps into a firm, rigid seat.

Every part of the tool is replaceable, and Atlas manufactures a complete line of replacement parts, including interchangeable cone and chisel bits.

BREAST PROTECTORS

In order to help solve a serious problem among women engaged in industrial war work, The Strauss Company, 978 Ewart Bldg., Liberty Ave., Pittsburgh, Pa., has developed a set of molded, vulcanized fiber breast protectors.



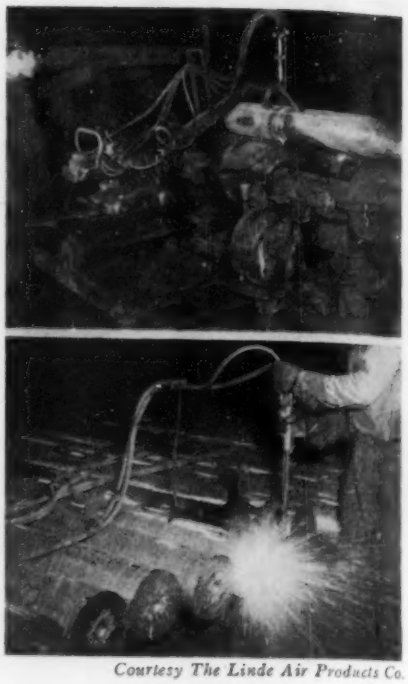
Strauss breast protectors, which are flesh-colored and available in three sizes, have extended ledges at the bottom of the cups to provide a base to resist blows. They are adjustable between cups, for width between breasts, and the light web harness is also adjustable in the back. It is recommended that breast protectors be worn over a slip or brassiere as illustrated. The harness, completely detachable, can be laundered and the cups can be sterilized.

The manufacturer has prepared descriptive literature and will furnish copies to all interested parties on request. Write for Bulletin No. 143.

CUTTING FLAMES BEGIN THE MANUFACTURE OF SEAMLESS TUBING

Two preparatory operations in the manufacture of seamless steel tubing are (1) cutting the round steel billet to size, and (2) centering the end for the piercing plug.

In the photograph *A* an oxyacetylene cutting machine is cutting off the undesired end of a 10-in. diameter round. Later, cut to proper length and lined up

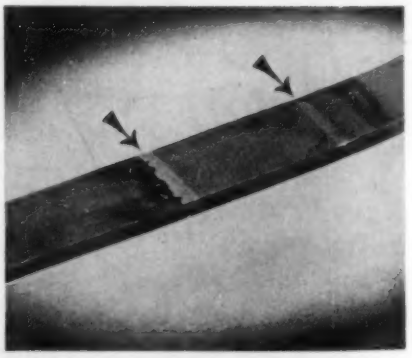


Courtesy The Linde Air Products Co.

side by side (photograph *B*) the rounds are quickly centered by means of a specially designed, manually controlled oxyacetylene cutting blowpipe.

CUTTING AIRCRAFT MOTOR COOLING FINS

Large users of vital high-speed steel in cutting cooling fins for aircraft engines, Continental Motors Corp. now effects great savings by utilizing scrap high-speed steel sections joined to mild steel body.



Accompanying photograph illustrates how this company fabricates this unusual tool by chamfering joints in X-shape and joining pieces with Castolin eutectic low-temperature welding alloy.

This low-temperature alloy provided a joint at 1300° F. with only localized heat-

ELECTROLOY ALLOYS for RESISTANCE WELDING ELECTRODES and DIES

Spot
Seam
Butt
Flash
Projection

ELECTROLOY ALLOYS were developed specifically for the resistance welding industry. ELECTROLOY ALLOYS cover the full range of physical properties necessary to the manufacturers and users of resistance welding equipment.

Our engineers will be glad to make recommendations for your special electrodes. Submit samples or specifications.

Catalog and prices available on request.

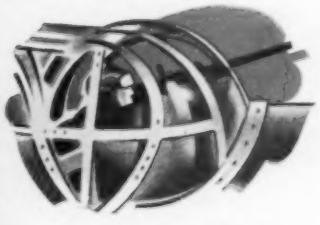
THE ELECTROLOY COMPANY, Inc. 1600 Seaview Avenue, BRIDGEPORT, Connecticut

SERVING THE ARMED FORCES

"... This award is your nation's tribute to your patriotism and to your great work in backing up our soldiers on the fighting front."

Under Secretary of War

EMERSON-ELECTRIC War Products



POWER-OPERATED AIRPLANE GUN TURRETS

These heavy-caliber fire power, armored turrets protect our Army-Navy Bombers and Torpedo planes against enemy fighter aircraft.

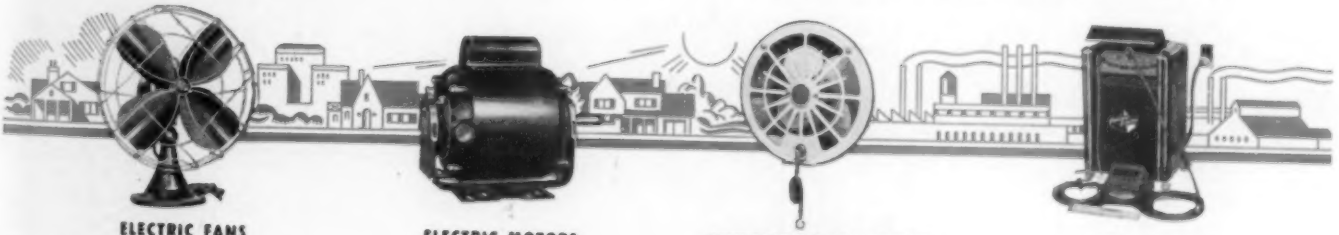
PARTS FOR ARTILLERY AMMUNITION

Precision-built shell bodies and boosters for U. S. Artillery are contributing to the offensive power of our armed forces.

ELECTRIC-MOTOR CONTROLS FOR AIRCRAFT

The fighting power and split-second maneuvering of modern war planes depend upon precision-built electric motor controls.

AFTER VICTORY...Back To The Job Of Serving The Nation



ELECTRIC FANS

The most complete selection of quality Fans in America, with the famous 5-Year Guarantee, inaugurated in 1914.

ELECTRIC MOTORS

For household, farm, commercial and industrial appliances and labor saving machines. . . . Also, for aircraft controls.

VENTILATING EQUIPMENT

Kitchen ventilating and attic cooler fans for homes. Exhaust and ventilating fans for industry and commerce.

A. C. ARC WELDERS

The most modern of metal fabricating methods is made universally available through these compact, portable units.

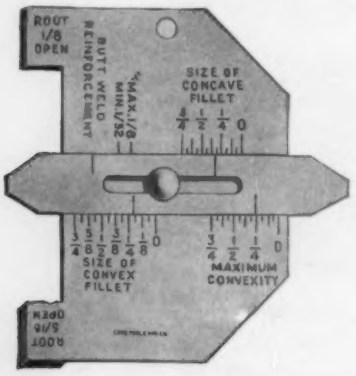
EMERSON ELECTRIC

THE EMERSON ELECTRIC MANUFACTURING COMPANY, SAINT LOUIS... Branches: New York • Detroit • Chicago • Los Angeles • Davenport

ing—thus preventing annealing of the heat-treated, high-speed steel which retains all its original hardness. Also the cutting edges are not affected. With the great scarcity of tools at present, one can easily realize the importance of this simple, efficient salvaging process.

WELDER'S MICROMETER

Chicago Tool & Engineering Co., 8366 S. Chicago Ave., Chicago, Ill., are now offering one of the finest welding gages ever developed. This new and essential instrument rightly called the Welder's Micrometer, enables a welder to meet exact specifications of butt- and fillet-type welds. Made in convenient pocket size ($2^1/_2$ x 3) it is handy and easy to operate. Welders can now accurately check the sizes of convex or concave fillets as well as check the permissible tolerance of butt-weld reinforcements.



Instrument is precision-built of chromium-plated steel with dimensional readings clearly indicated. Instrument sells for only $3.00.

Chart illustrating its various uses and specifications for ferrous materials is available upon request.

WELDER'S GLOVE

At the request of one of the large shipyards where much overhead welding is done, the Industrial Gloves Company of Danville, Ill., has developed a new mitten-guard, or "booster" for use with any welder's ordinary gauntlet glove. On most overhead welding jobs considerable costly damage is done to the left-hand gauntlet at the junction of thumb and palm. Made of special heat-resistant leather, this guard, designed as a mitten with open-end thumb, is slipped easily over the left hand glove when actual welding is started. The construction of the guard at the thumb opening provides the needed protection against sparks and molten metal that ordinarily drop down and rest on that portion of the glove—not only damaging the glove itself but oftentimes causing severe, painful burns to the welder. The new guard is readily slipped off after the welding is completed so that the gloved hand is ready for the necessary accurate handling of parts, tools, etc. The "booster" guard will save many hours of glove-wear at small cost—and at the same time will give the welder much extra protection where it is badly needed—on the left hand.

NEW SEGMENT CUTTING METHOD

A highly efficient method for conserving steel plate stock, and at the same time increasing the number of segments cut from it, was recently suggested to the General Electric Co. by Spencer K. Fredericks, a G-E welder. Spencer's method involved changing the arc length and rearranging the nesting of the templates of segments cut from large rectangular sections of 1-in. and $1^1/_2$-in. steel plate stock.

ARE YOU HAVING REJECTIONS FROM SPOT WELD BURNS?

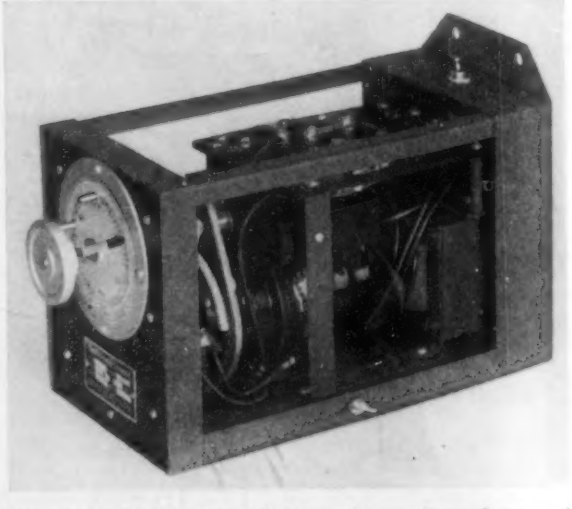
ARE YOU TROUBLED FROM TOO MUCH HEAT?

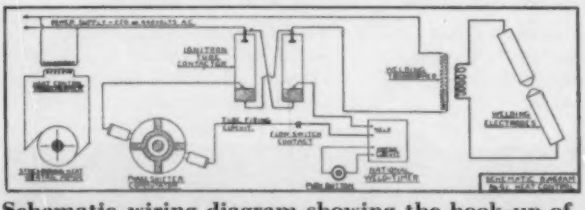
NATIONAL HEAT CONTROL UNITS PROVIDE FINGER-TIP, INSTANTANEOUS CHANGE OF TRANSFORMER HEAT IN 45 GRADUAL INTERMEDIATE STEPS, BETWEEN EACH PRIMARY TAP.

"Number 2 Tap is Too Low, but Number 3 Tap is Too Hot," complains the Operator.

TRY HEAT CONTROL for the Ideal Setting, and Compensate for Voltage Variations Too. Make Clean, Uniform Welds, Minimize Spitting, and Eliminate Secondary Grinding Operations.

DO IT THE NATIONAL WAY, WITH IGNITRON CONTACTORS, AND MODEL 41 HEAT CONTROL.





Schematic wiring diagram showing the hook-up of Heat Control in a Welding machine set-up.

Model 41 Heat Control, illustrated here, is an ingenious, yet simple Control, that synchronously rotates a copper cross shaped segment between two brushes, which are connected in series with the Ignitron tube firing circuit. Brushes are positionable, and in moving same, produce Phase Shifting, or in simple terms, crop off any desired amount of the current feeding the welding transformer, reducing the Heat from maximum down to substantial zero.

NATIONAL TIME & SIGNAL CORPORATION

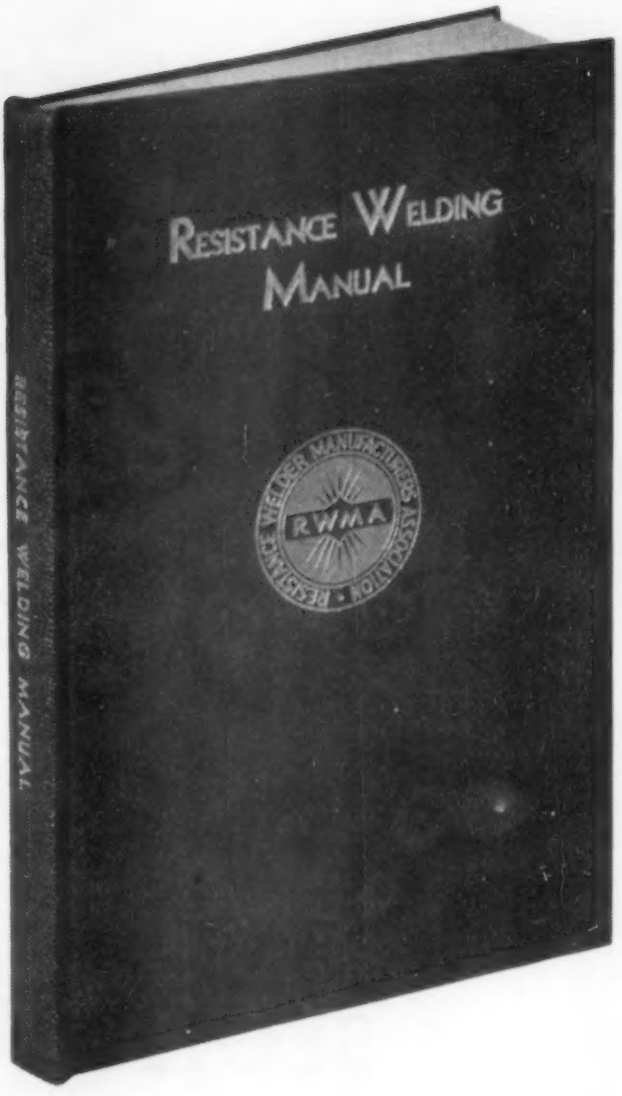
600 E. MILWAUKEE AVENUE DETROIT, MICHIGAN

JUST PUBLISHED

The first and only

authoritative reference book

covering all phases of resistance welding exclusively.



6 Chapters
286 pages
205 tables, charts and illustrations

The RESISTANCE WELDING MANUAL was written and prepared by a group of resistance welding experts under the joint sponsorship of the Resistance Welder Manufacturers' Association and the American Welding Society.

All of the material in the book was originally included in the second (1942) edition of THE WELDING HANDBOOK published by the American Welding Society.

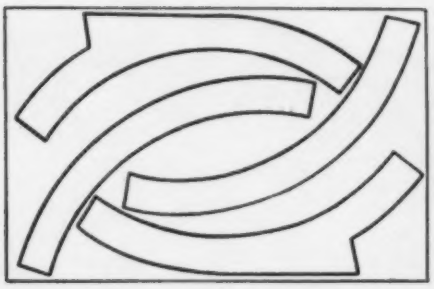
Realizing the urgent demand for resistance welding information and data, the Resistance Welder Manufacturers' Association, by arrangement with the American Welding Society, has now separately published all of the HANDBOOK material dealing with resistance welding. By this arrangement, it is now possible to obtain all of the resistance welding material without the necessity of securing the entire WELDING HANDBOOK.

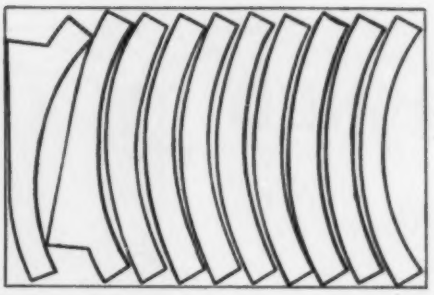
This material has not been condensed or abridged in any manner.

Price $2.50 postpaid

THE RESISTANCE WELDER MANUFACTURERS' ASSOCIATION

505 ARCH STREET PHILADELPHIA, PENNSYLVANIA





By reducing the arc lengths of the segments from 90 to 60°, and by arranging the templates crosswise rather than lengthwise on the plate stock before cutting, the amount of scrap left from the operation is greatly reduced. In addition, the nesting arrangement results in sections of uniform shape being so placed that a battery of acetylene torches cuts through them simultaneously, rather than singly, thus conserving man-hours and speeding up production.

These segments are welded together to form large motor frames. On a recent job requiring the cutting of sufficient segments for 72 large motors, the new method effected a saving of 20% in scrap over the former method.

General Electric paid Spencer $750 for his suggestion.

CABLE CONNECTORS

The welding industry has long needed a safe, quick-change cable connector and this new rapid cable connector meets every requirement with many outstanding features. For example, the screw and tapered sleeve construction makes locking positive and a simple 3/4 turn in opposite directions, connects or disconnects cable in less than 3 sec. No tools are required. No bolts, nuts, washers or gadgets to loosen and no tape to wrap or remove. This construction also assures highest possible conductivity and eliminates the possibility of shorting, fire hazards and damage to work or equipment.

Write for Bulletin V-3 giving complete details, prices, etc. Address all inquiries to Chicago Tool & Engineering Co., 8366 S. Chicago Ave., Chicago, Ill.

SECTION ACTIVITIES

BIRMINGHAM

Mr. G. N. Sieger, President and General Manager of S-M-S Corp., Detroit, was the guest speaker at the February 9th meeting of the Birmingham Section. Mr. Sieger spoke on the ever-interesting subject of "Resistance Welding."

BOSTON

The February 8th meeting of the section was a joint meeting with the Boston Section of the American Industrial Radium and X-Ray Society and was held at the Engineers' Club, Boston.

The general topic of the meeting was "The Inspection and Weld Repair of Steel Castings." Mr. I. L. Bossler, asst. supt., Reading Steel Foundry, American Chain and Cable Co., Reading, Pa., spoke on "Defects in Steel Castings" and Mr. Allen G. Hogaboom, welding supervisor, Bethlehem Steel Co., Fore River Yard, Quincy spoke on "Weld Repair of Steel Castings."

Mr. Frank Tibbetts, radiographer at the Fore River Yard, served as technical chairman for the meeting and conducted a discussion period at the conclusion of the talks. He also described the role of radiographic inspection in the improvement of casting quality.

CINCINNATI

"Industry Goes to War" was the subject of an interesting talk given by Burnham Finney, Editor, *Amer. Machinist*, at the joint meeting of the American Society of Tool Engineers and AMERICAN WELDING SOCIETY, Cincinnati Sections, held on February 9th, at the Hotel Alms Grill.

CLEVELAND

A War Production Board Panel sponsored by local organizations, including the Cleveland Section of the AMERICAN WELDING SOCIETY and the Cleveland Chamber of Commerce, was held on January 27th at the Hotel Carter. The Panel of meetings was called the Northern Ohio War Production Clinic for Small Manufacturers. Mr. R. J. Kriz, chief inspector, James H. Herron Co., was chairman of the Welding Panel. Discussion leaders were L. Burr, Supt., The Austin Co., A. F. Davis, Vice-President, The Lincoln Electric Co., H. Dyer, The Linde Air Products Co., F. A. McCloud, Supt., Thornton Co., and H. L. McCreery, Federal Welding & Machine Co.

The regular meeting of the Cleveland Section of the AMERICAN WELDING SOCIETY was held Wednesday evening, February 10th, 8 o'clock at the Cleveland Engineering Society, 2136 E. 19th St.

The main feature of the evening was a paper entitled, "Stainless Electrodes for War Production" by R. David Thomas, Jr., director of research and engineering of the Arcos Corp., Philadelphia, Pa.

His subject included a discussion of the commercial stainless electrodes, their analyses, coatings and the application of these stainless electrodes in the welding of armor, stainless parts for aircraft and stainless vessels for the power industry, chemical industry and munitions industries.

The Coffee Talk, "My People as I Knew Them" by A. C. Kayanan discussed the people of the Philippines.

For the March meeting, the Section has scheduled a talk by E. A. Mallett, "High Lights of Resistance Welding," and a Coffee Talk and movie, "Cannon on Wings," Bell Aircraft "Airacobra."

COLUMBUS

The February meeting of the Columbus Section was held on the 12th at Battelle Memorial Institute. Mr. C. A. Liedholm, chief engineering metallurgist, Curtiss-Wright Corporation, discussed the subject "Welding Airplane Propellers."

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Thank You,
Mr. Secretary-
Mr. Patterson, we of "VICTOR" are proud that our Army and Navy has bestowed upon our company and us the coveted Army-Navy Production Award. ★ This award challenges us to do an even better job . . . worthy of the brave men who fight for us.
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844-54 FOLSOM STREET
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DETROIT

One of the Detroit Section's most interesting meetings was held on Friday, February 5th, in the Rackham Memorial Building.

The movie, "Welding of Aluminum," courtesy of the Aluminum Corp. of America, is excellently produced and is recommended to all Sections having problems of aluminum welding and brazing in their territory.

Captain T. L. Sullivan, U. S. Army Air Corps, gave some interesting and humorous side lights on "Welding as Viewed by the Air Corps Officer."

Mr. George Mikhalapov, supervisor of welding research, War Met. Alloys Committee, National Research Council, spoke on "Welding in the Aircraft Industry," and was at his best. The facts submitted by him, sincerely yet with a sense of humor, were a source of interest and value.

Refreshments of doughnuts and cider were served in the Snack Bar of The Engineering Society of Detroit after the meeting.

The Flint group had a "Stump the Experts" program at their noon and evening meetings, Thursday, February 18th, at the Capital Hotel, Flint. The Board of Experts included: R. S. Komarnitsky, Standard Steel Spring Co., Metallurgy of Welds; E. G. Biederman, Fisher Tank Division, Arc Welding; M. R. Scott, The Linde Air Products Co., Oxyacetylene Cutting & Welding; R. W. Staggs, Westinghouse Electric & Mfg. Co., Electronic Controls; Clyde Kaunitz, National Electric Welding Machines Co., Resistance Welding. G. N. Sieger, Secretary, acted as Master of Ceremonies.

Mr. Leon Bibber, welding engineer, Carnegie-Illinois Steel Corp., will be the speaker at the April 1st meeting.

GEORGIA

The reorganized Georgia Section announces the election of the following officers: M. Stellman, *Chairman;* D. B. Hunt, *Vice-Chairman;* E. Guillot, *Treasurer;* J. V. Turner, *Secretary.*

The first general meeting was held on the night of February 12th at the Blue Flame Room of the Atlanta Gas Light Co., at which time, Mr. G. N. Sieger, President of S-M-S Corp. discussed "Resistance Welding."

INDIANA

A joint dinner meeting of the local Sections of the AMERICAN WELDING SOCIETY and American Society for Metals was held on February 16th at Anderson Y.M.C.A. A film showing interesting methods of salvaging tools in some of the plants of the International Harvester Co. was shown immediately after dinner. The speaker of the evening was Mr. H. E. Cole, Handy and Harman Service engineer, Chicago. His topic was "Uses of Silver Solder in Industry." This talk was supplemented by an actual demonstration in which broken tools were low-temperature brazed and the methods explained.

KANSAS CITY

Friday, January 29th, the eight engineering societies including the AMERICAN WELDING SOCIETY held a joint afternoon dinner and evening session with the War Production Board. The object was to disseminate to all the experience of various manufacturing groups engaged deeply in the war effort.

From all reports the results have been good. The dinner at 6 P.M. was well attended with a large representation from the local chapter of the A.W.S.

With three other panels in concurrent session, none was more interesting than that provided by the AMERICAN WELDING SOCIETY. Mr. J. A. Hall presided in capable fashion and commented on the capacity audience which filled the Junior Ballroom of the Hotel President.

Mr. Ray Gabler of the Butler Manufacturing Co. presented slides to show some of the products his company was producing which were helping greatly in bringing the war to a successful conclusion for the United Nations. Mr. J. L. Fizzell, Nation Steel Products Co., led a question-and-answer period.

For the main address Chairman "Bill" Farr had secured Mr. J. G. Magrath in Charge of Promotion for Air Reduction Sales. No more fortunate choice could have been made. While Mr. Farr synchronized the lantern to the tempo of the speaker, Mr. Magrath unleashed a rapid-fire illustrated lecture on the subject of shipbuilding on the West Coast. Pictures of Henry Kaiser's methods of producing ships in 28½ days together with the extremely fast and interesting MaGrath interpretation kept the audience on its mental toes up to the 170th—the very last —slide had been shown. As the crowd dispersed, it gave almost unanimous comment that this had been one of the most stimulating sessions it had ever attended.

LOS ANGELES

At the January meeting held on the 21st, Mr. Charles Hibert, assistant chief of manufacturing research dept. of the Consolidated Aircraft Co., San Diego, presented a most interesting discussion on "Brazing as a Production Tool." He brought up some very interesting and new uses for brazing in the aircraft industry and pointed out various methods of design in which many castings can be eliminated to simpler and lighter design made possible by the use of brazing. Considerable discussion from the floor took place.

The United States Bureau of Mines was kind enough to loan the section their new sound 16-mm. motion picture "Welding of Aluminum." This is an extremely interesting and well-done picture. It takes about 35 min. to run and shows very graphically the various methods used in welding and brazing aluminum.

Special praise is due the Los Angeles Section for the record attendance at monthly meetings and for its aid to the State Department of Education in the preparation of a book, *Maritime Welding.*

MILWAUKEE

The regular monthly meeting of the Milwaukee Section was held on January 22nd. "Men of the F.B.I.," a sound, motion picture by the Federal Bureau of Investigation, was shown after the dinner. Mr. E. J. Wellauer, supervisor of research and metallurgy, gave the welding address on "Practical Aspects of Welding Metallurgy." Mr. Wellauer's talk was illustrated with slides and covered some of the factors which determine the physical properties of welds.

NEW YORK

The regular monthly technical meeting of the New York Section was held on Tuesday, February 9th, at the Engineering Societies Building. The subject for the evening was shipbuilding and members of the Society of Naval Architects and Marine Engineers were invited to attend. Technical Chairman for the evening was David Arnott, Vice-President and chief surveyor, American Bureau of Shipping, New York.

The speaker for the evening was LaMotte Grover, structural welding engineer, Air Reduction Sales Co., New York, who spoke on the subject "Control of Welding in Shipbuilding." Mr. Grover's paper dealt with a number of important phases of welding and cutting in connection with shipbuilding, including control of welding properties and fitting-up methods. It also covered the problem of distortion in welded members, its cause and effect and its control by means of close regulation of welding methods and techniques, the use of welding platforms and jigs and the employment of positioners for many types of work. Mr. Grover illustrated his very interesting talk with numerous lantern slides.

Following Mr. Grover's talk three United States Navy motion pictures were shown on the following subjects: "American Seapower," "First Line of Defense," and "Submarines at Sea."

The evening opened with a half-hour question-and-answer period conducted by C. Kandel.

The March meeting will be held on the 9th. Mr. H. O. Klinke of the Republic Aviation Corp. will speak on "Aeronautics." A movie "Target for Tonight" will be shown.

The April meeting will be held on he 13th. "Structural Welding" will be the subject.

"Silver Brazing" will be the subject of the May 11th meeting.

NORTHERN NEW JERSEY

"Aluminum Night" was held on January 19th and was a huge success. Mr. T. P. Hubert, Manager, Newark Office, Aluminum Co. of America, and his associates, put on a most interesting evening. A very interesting film was presented as well as side lights on the welding and fabrication of aluminum by the Aluminum Co.'s various representatives.

NORTHWEST

Mr. C. E. Swift, welding engineer,

Ampco Metal, Inc., spoke on "Welding of Copper Alloys" at the January 18th meeting of the Northwest Section.

At a special meeting held on January 22nd, Mr. J. G. Magrath of the Engineering Dept., Air Reduction Sales Co., gave an illustrated talk on "The Welding Arc and the Cutting Torch at the West Coast Shipyards."

At the February meeting held on the 15th, Mr. A. T. Mortrud, welding engineer, Western Welding & Engineering Co., Chicago, spoke on "Cost of Welding."

PEORIA

The following officers were elected by the Peoria Section on January 27th: *Chairman*, Clifford Wimmer, Keystone Steel & Wire Co.; *Vice-Chairman*, John F. Riest, Keystone Steel & Wire Co.; *Secretary*, Al Runkel, R. G. LeTourneau, Inc.; *Treasurer*, Robert R. Rutledge, A. Lucas & Sons; *Executive Committee*, to serve for two years, Alfred A. Wald, Caterpillar Tractor Co., L. A. O'Day, Lincoln Electric Co., and Harold Baldwin, R. G. LeTourneau, Inc.

PHILADELPHIA

The regularly scheduled January meeting was postponed in favor of a Joint Panel Discussion, held at the Broadwood Hotel on January 18th, in conjunction with the War Production Committee. The meeting opened at 4:00 P.M.

Welcome to the conference was extended by Mr. D. W. R. Morgan, Works Manager, Westinghouse Electric & Mfg. Co., general chairman of the Conference.

Brig. General H. F. Safford, U. S. Army, spoke on "Production Side of the War Effort."

Mr. John S. White, Personnel Manager, I.T.E. Circuit Breaker Co., offered a survey of "Women in Industry."

Mrs. Frances H. Welzel, supervisor, Bureau of Women and Children, Pa. State Dept. of Labor and Industry, outlined briefly the Pennsylvania legislative restrictions and accomplishments in connection with "Women at Work in War Time."

A motion picture, "Salvaging Waste Light for Victory," was shown through the courtesy of the Philadelphia Electric Co. and Dupont Co.

Dinner was served in the Grand Ballroom of the Broadwood Hotel at 6:30 P.M., and, following this, the individual panel discussion groups retired to their respective meeting rooms and proceeded with their assigned topics for discussion.

The March meeting of the Philadelphia Section will be held on the 15th. The subject will be "Structural Design for Welding."

The April meeting will be held on the 19th. The subject will be "Gas Welding and Cutting."

The May meeting will be on the 17th. The subject will be "Welding in Aircraft Production."

All meetings start at 8 P.M., in the Engineers' Club, 1317 Spruce St., Philadelphia.

PITTSBURGH

The January meeting of the Pittsburgh Section was attended by nearly one hundred fifty members and guests, notwithstanding gasoline rationing restrictions on use of autos and activities due to defense work in this area.

Mr. Howard K. Hogan, special representative (welding), Vocational Training for War Production Workers, U. S. Office of Education, Washington, D. C., gave a splendid lecture on "Welder Operator Training" as covered in the program sponsored by the U. S. Office of Education through the public vocational schools, industrial plants, etc.

An enlightening picture of the scope of this program was pointed out by Mr. Hogan and its importance to war production work.

Following the lecture, parts five and six of the General Electric Co.'s color sound films, illustrating vertical- and overhead-position welding were shown and proved most acceptable following the talk by Mr. Hogan.

After a short discussion of questions from those in attendance the meeting was adjourned with a rising vote of thanks to Mr. Hogan for his splendid talk.

ROCHESTER

The regular monthly dinner meeting of the Rochester Section was held on February 4th at Tood Union, University of Rochester. Mr. M. H. Potter, Sales Manager, Marquette Mfg. Co., Inc., spoke on the subject of "A.-C. Welders."

Old-time comedy entertainment followed the regular meeting.

SAN FRANCISCO

"Resistance-Welding Applications" was presented by Mr. Mark Cassimus of Sullivan-Cassimus Co., at the January 29th meeting of the San Francisco Section, held at the Athens Athletic Club, Oakland, Calif. Mr. Cassimus gave some valuable information regarding present-day practices.

At the suggestion of Mr. E. J. Wohler of the United Engineering Co., the latter portion of the meeting was devoted to an open discussion of some of the headache-producing problems encountered in the course of a day's work.

SOUTH TEXAS

The South Texas Section held a meeting on Thursday, January 14th, at the Houston Engineers' Club, Houston, Tex. Mr. Courtright made a report for the Periodicals Committee. At Mr. Hughen's suggestion, Mr. Jackson agreed to furnish the Secretary with a list of available literature to be sent out with the meeting notices.

Mr. H. D. Lucas, field engineer, Handy and Harman, gave an interesting talk on "Fundamentals and Application of Low-Temperature Silver Alloy Brazing." Mr. Lucas stressed the conservation of materials that can be attained with silver alloy brazing. He showed how many kinds of tools could be reclaimed and quickly put back in operation.

WASHINGTON, D. C.

On January 26th, Mr. J. H. Cooper of the W.P.B. addressed the Washington, D. C., Section on "Resistance Welding as Applied to Defense Projects."

Mr. Cooper's talk was of great interest to the Section and his up-to-date applications and uses of resistance welding were much appreciated.

The Washington Section is increasing its mailing list to cover all Government Bureaus, Armed Services and other societies in Washington, so any interested parties may attend the meetings and hear the speakers.

YORK-CENTRAL PA.

Mr. A. H. Yoch, machine cutting specialist connected with Air Reduction Sales Co., presented an illustrated talk on "Machine Gas Cutting—Mass Production for Welded Fabricated Ships and Ordnance Materials," at the January 20th meeting.

List of New Members

January 1 to January 31, 1943

BOSTON

Anderson, Palmer (D), 16 Chester St., Allston, Mass.

Andrews, W. E. (D), 77 Boston Ave., W. Medford, Mass.

Bauer, Wm. H. (D), 103 Hardy Pond Rd., Waltham, Mass.

Bernard, Arthur E. (D), 25 Maverick St., Apt. 8, E. Boston, Mass.

Boucher, Edmond J. (D), 325 E. 8th St., So. Boston, Mass.

Canal, J. E. (D), 8 Shuman St., Peabody, Mass.

Collins, L. G. (D), 9 Burridge Pl., Malden, Mass.

Corinka, Henry A., Jr. (D), 242 Lincoln St., Winthrop, Mass.

Cunningham, John J. (C), Artisan Metal Products, Inc., West St., Charlestown, Mass.

D'Arcangelo, E. (D), 59 Hull St., Boston, Mass.

Graziano, Thomas (C), 68 Paul St., Dedham, Mass.
Irvin, Wm. J. (B), 121 Ashmont St., Dorchester, Mass.
Johnson, Harry R. (D), 17 School St., Methuen, Mass.
Johnson, Wm. B. (D), Mill St., Burlington, Mass.
Jsouprahakis, Charles (D), 80 Savoy Ave. Dracut, Mass.
Kane, James J. (D), 71 Center St., Lawrence, Mass.
MacDonald, Angus F. (B), 32 Cameron St., Everett, Mass.
MacGregor, Robert M. (C), 3 Clinton Rd., Cape Elizabeth, Me.
MacRae, John F. (B), 141 W. Selden St., Mattapan, Mass.
Martin, Arthur (D), 13 Ralph St., Lowell, Mass.
Martin, Gerry G. (D), 103 Chambers St., Boston, Mass.
McGorty, George F. (C), 5 Lincoln St., Hudson, Mass.
McIntosh, Francis J. (D), 881 Huntington Ave., Boston, Mass.
McNeilly, James M. (B), 51 Holten St., Peabody, Mass.
Mennelly, Phillip J. (D), 2057 Commonwealth Ave., Auburndale, Mass.
Mulrey, Joseph F. (D), 45 W. 7th St., So. Boston, Mass.
Murray, Clifford H. (C), 39 Randall St., Worcester, Mass.
Nadeau, George (D), 65 Bailey Rd., Somerville, Mass.
Newman, N. A. (D), Covington Ave., Billerica, Mass.
Orf, George, (D), 3 Tremont St., Charlestown, Mass.
Pecora, Thomas (D), 12 Pearl Ave., Revere, Mass.
Perkins, Wilford D. (D), 50 Ester St., Mass.
Perry, Domingo F. (D), 4 Carlton St., S. Dartmouth, Mass.
Powell, Howard C. (C), 47 Putnam Rd., Somerville, Mass.
Pritchett, R. E. (D), 82 Cleveland Ave., Everett, Mass.
Reeves, Walter F. (D), 242 Elm St., Cambridge, Mass.
Rich, H. O., Jr. (D), 191 No. Shore Rd., Revere, Mass.
Santino, M. L. (D), 42 Corey St., Everett, Mass.
Small, Walter A. (D), 35 Boston Ave., Somerville, Mass.
Steele, William A. (D), 11 Royal Rd., Mattapan, Mass.
Sweeney, Wm. H. (D), 187 Billerica Rd., Chelmsford, Mass.
Thompson, H. C. (B), 249 Haverhill St., Methuen, Mass.
Wilson, Bernard L. (D), P. O. Box 25, Charlestown, Mass.
Wolcott, Paul A. (B), 185 Powder House Blvd., Somerville, Mass.

CANADA

Manchester, Gordon E. (D), 25 Askiw St., Leamington, Ont., Canada.
Stocks, Murray (C), Box 224, Arvida, Que., Canada.

CANTON

Lindimore, C. O. (C), 231 W. Main St., Carrollton, Ohio.

CHICAGO

Anen, Raymond J. (B), 2612 Harvey Ave., Berwyn, Ill.
Auld, John M. (D), 2553 W. 104th St., Chicago, Ill.
Foege, H. W. (C), 907 Seward St., Evanston, Ill.
Grubbs, L. (D), 6249 Van Buren St., Hammond, Ind.
Kirchberg, Ed. (D), 908 Leonard Parkway, Chicago, Ill.
Lindley, L. Frank (C), Taylor-Winfield Corp., 543 W. Washington Blvd., Chicago, Ill.
Lynk, Leo F. (C), 807 Mulford St., Evanston, Ill.
MacDonald, Harry (C), 15317 Vine Ave., Harvey, Ill.
Mannino, Frank J. (D), 2811 S. Lowe Ave., Chicago, Ill.
Matasovic, John L. (C), 8642 Euclid Ave., Chicago, Ill.
Quass, Louis M. (D), 905 S. Cuyler Ave., Oak Park, Ill.
Sandrik, John (C), 1317 W. 19th St., Chicago, Ill.
Shaski, John J. (D), 115 Stephen St., Lemont, Ill.
Turton, Joseph F. (D), 2235 W. Cermak Rd., Chicago, Ill.
Wildeis, Henry (C), 2729 Mildred Ave., Chicago, Ill.
Wolff, Louis J. (B), Welding Serv. & Supplies Co., 1338 S. Cicero Ave., Cicero, Ill.

CINCINNATI

Benter, J. G. (C), The Ohio River Co., Addyston, Ohio.
Kien, Clifford G. (D), 2017 Hopkins Ave., Norwood, Ohio.
Ward, Howard J. (D), 536 Kensington St., Middletown, Ohio.

CLEVELAND

Kestner, M. W. (C), 2222 Searsdale Ave., Cleveland, Ohio.
Lelless, Cecil (C), R. D. 3, Willoughby, Ohio.
Overbeke, Robert E. (C), 2649 Edgehill Rd., Cleveland Hgts., Ohio.
Steinman, Ernest A. (C), 29450 Detroit Rd., Westlake, Ohio.

COLUMBUS

Farris, W. A. (C), The Ohio Power Co., Duncan Falls, Ohio.
Heern, O. L. (D), 1117 McAlister Ave., Columbus, Ohio.
Patchen, G. B. (D), 1677 E. Whittier St., Columbus, Ohio.
Sears, Paul J. (B), Jeffrey Mfg. Co., Columbus, Ohio.
White, Arlie E. (D), 1515 Minnesota Ave. Columbus, Ohio.

DETROIT

Biederman, Ed. G. (B), Fisher Body Corp., Tank Arsenal, Grand Blanc, Mich.
Bruce, Austin E. (B), Capitol Hotel, Flint, Mich.
Cook, Hugh (B), 1411 Downey St., Flint, Mich.
Dillon, Kenneth E. (B), 2012 Detroit St., Flint, Mich.
Dwyer, A. M. (B), Severance Tool Co., Saginaw, Mich.
Eckermann, Leo A. (C), Steel Plate & Shape Corp., 15050 Woodward Ave., Detroit, Mich.
Genter, David H. E. (B), Standard Steel Spring Co., A. P. Div., John R. & E. Elizabeth, Detroit, Mich.
Heidler, Henry R. (B), Standard Steel Spring Co., A. P. Div., John R. & E. Elizabeth, Detroit, Mich.
La Nicca, W. B., Jr. (C), Steel Plate & Shape Corp., 15050 Woodward Ave., Detroit, Mich.
Makela, William E. (B), 122 Sawyer St., Grand Blanc, Mich.
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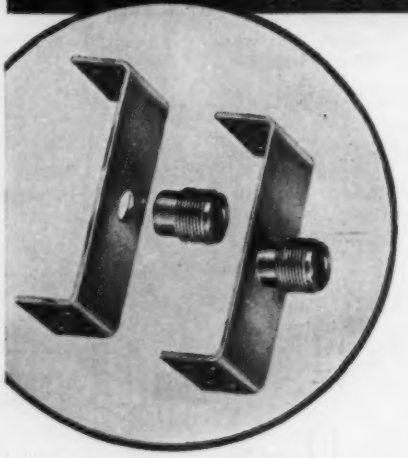

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